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Setting blue water footprint caps for Iran’s water resources

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Image on cover page: Shrinking Lake Urmia from July 1998 to June 2014 (Kaveh Madani)

Preface

This research is the report of the MSc. graduation research that helps to set caps for Iran's blue water footprint.

This report is the final work of my career as a student at the University of Twente. In this research, I gained knowledge on EFR estimations, blue water scarcity assessment and blue water footprint cap settings. And I got an opportunity to explore the current blue water situation in Iran.

I would like to thank my two supervisors, Maarten and Fatemeh. They are so professional and patient when I have problems both in research and life. The past year was a special year, I came back to China to finish my thesis in the last months of the research period. Fortunately, my supervisors kept touching with me and gave me quick and comprehensive feedbacks. A special thanks goes to Maarten, who is careful to my study life giving many suggestions to me via email during the research. I also would like to thank Fatemeh gave me useful information about Iran and thesis writing. Also, my gratitude goes to Arjen Hoekstra, who is the enlightener for me to gain an insight into water footprint. I had known this concept since studying for the bachelor's degree and I have been admitted into the University of Twente to study water footprint. Personally, I mourn his death and the great loss to the science.

Finally, I want to thank all the people I met in the Enschede and people in my home town who gave help to me in the quarantine days. Especially I would like to thank my family, my friends, and my two cats Soda and Tofu bun who encourage me all the time. The year 2020 was such a difficult but impressive year, I believe that the world will be more beautiful because of our unity.

Hanying Jin
Zhejiang, 2021

Summary

Feeding the growing population mainly occurs at the cost of overexploiting limited water resources in many regions of the world which consequently results in intensifying water scarcity. Setting blue water footprint caps (BWCs) may help with limiting such an overexploitation. In this research, we carried out a water footprint assessment to set caps on Iran's surface and groundwater water resources.

In this regard, monthly/annual blue sustainability levels were first determined by assessing blue water scarcity (BWS) and EFR violations in order to see to what extent the current environment is violated in Iran. Thereafter twelve scenarios were formulated for setting cap options according to four demand fulfilment levels (DFLs = 100%,85%,75% or 60%) and three monthly surface water caps (SWC = maximum, average or minimum BWA_{SW}). BWC options were split into SWCs and groundwater caps (GWCs). To address spatial and temporal variability in BWAs, each cap option was established for each province at monthly scale. The trade-offs: [1]between satisfying blue water demand and preserving environmental flows; [2]between violating surface water resources and constraining groundwater resources were consequently quantified. Finally, a set of appropriate provincial caps were selected among twelve scenarios by assessing the quantified trade-offs.

The assessment showed that 53% of surface water runoff (BWR_{SW}) and 75% of groundwater recharge (BWR_{GW}) should be allocated as EFR_{SW} and EFR_{GW} respectively. Nevertheless, the results indicated that the hotspots of Iran increased from 9 to 20 provinces during the study period. Among three assessed consumption sectors (agriculture, industry and domestic), the agricultural sector was always the first contributor of total EFR violations, which accounts for more than 90%.

Applying 75% DFL is shown to be a BWC option with 95% annual demand being satisfied for most provinces in Iran. This BWC option also has been chosen as an appropriate BWC for most provinces except provinces that are facing quite severe BWS and quite moderate BWS. Water-scarce areas require a stricter cap, while water-rich areas can establish a relatively looser cap. Groundwater resources contribute more to the total blue water supply for most of the provinces under the chosen caps, and both surface water and groundwater resources can be largely preserved under such caps.

Uncertainties are inevitable because of the natural variability of blue water and the method variabilities. Applying local-fit EFR methods and establishing a more feasible cap-option system can be the main focus of future studies.

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Chapter 1

Introduction

In this research, we first assessed the variability of BWA and the current sustainability levels of Iran's blue water resources. Then, provincial caps were set for the country's surface and groundwater resources, which provides insights for reallocating the limited blue water resources in a way that meets the caps. This chapter includes the following issues: (i) stating the current challenges of Iran's water resources in Section 1.1; (ii) introducing the concept of capping water resources in Section 1.2; (iii) stating the goals and scope of the research in Section 1.3; (iv) introducing the study area in Section 1.4; and (v) providing further outlines of this thesis in Section 1.5.

1.1 Problem Statement

In recent decades, large quantities of areas are facing water scarcity problem which poses a threat to sustainable development of human society. Due to the increasing population and water demand, a variety of problem has arisen such as groundwater table decline (Bierkens et al., 2019; Famiglietti et al., 2011; Karami et al., 2005; Konikow et al., 2005), land subsidence (Faunt et al., 2016; Galloway et al., 1999; Motagh et al., 2008; Sun et al., 1999) and lake shrinking (Hesami et al., 2016; Liu et al., 2006), which have serious damage to the whole ecosystem (Doell et al., 2014).

Iran is a mostly arid to semi-arid country (Amiri et al., 2010; Ashraf et al., 2014; Hesami et al., 2016; Madani, 2014). The average annual precipitation of Iran is 228 mm, which is less than one-third of the average annual precipitation in the world (814 mm) (AQUASTAT, 2016; Karandish et al., 2017). Besides, it is unevenly distributed over time and space (Amiri et al., 2010). Although the natural precipitation condition is such severe, the rising water demand makes the current situation even worse. According to the global assessment of Hoekstra and Mekonnen (2012), during the period of 1996 – 2005, Iran has the second-largest blue water footprint of national consumption per capita (589 m^3/y per capita) on average (Hoekstra & Mekonnen, 2012). Blue water footprint (BWF) measures the consumption of so-called renewable blue water resources, in other words, the abstraction of surface water and renewable groundwater resources from the catchment or the aquifer insofar as it does not return to the same catchment or aquifer in the form of return flow (Hoekstra, 2019). The policy focuses on food self-sufficiency, but because of the low efficiency and high intensity of irrigation, it makes the agricultural sector as the largest fresh water consumer, accounting for more than 90% of the total water withdrawal (Faramarzi et al., 2010). Due to the unavailability of sufficient surface water resources, cropping systems in Iran mainly rely on groundwater resources; hence, rapid depletion of groundwater becomes a big challenge of Iran's irrigated agriculture. Groundwater contributes 55% of the total water demand in Iran and more than 90% is consumed by the agriculture sector (Madani, 2014). The side effects of groundwater depletion may include increased sea-level rise (Konikow, 2011;Wada et al., 2012) and regional land subsidence (Motagh et al., 2008).

To relieve the looming water crisis in Iran, the prior thing is to gain an insight into current blue water sustainability levels by using appropriate indicators. And according to the blue water overuse, it is of major importance for Iran to set ceilings for both surface water and groundwater use.

1.2 Water Footprint Cap

Considering the current excessive water withdrawal in Iran, there is a need to define a so-called cap to restrict its blue water use. The blue water footprint cap (BWC) represents the maximum sustainable level of consumptive blue water use in a certain area and during a certain period. The idea of setting a cap on water use as a policy tool was firstly adopted in the Murray-Darling Basin in Australia. However, this cap was only introduced on diversions of surface water use from the basin, whether the cap really put a sufficient limit on sustainable water use in both surface water and groundwater in the long term was still unknown (Hoekstra, 2019). Moreover, once the regulation of surface water use is set up, the need for freshwater may lead to unlimited groundwater abstraction. Groundwater outflow forms the baseflow of rivers, which is essential to maintain for people and the ecosystem downstream (Hoekstra, 2019). Besides, the side effects of groundwater depletion were also described in Section 1.1. Therefore, not only surface water consumption needs to be regulated, it is also necessary to set a cap for renewable groundwater resources.

As a relatively new policy instrument, setting WF caps is still novel. The starting point of setting BWCs is assessing BWA and sustainability levels. From this point, it is important to consider the trade-offs between water demand fulfillment and EFRs violations, and to assess to what extent the BWC options satisfy EFR intra-annually and inter-annually. This study contains these two main parts to make the possibility of preventing overexploitation of limited freshwater resources and to give insights of policy making in blue water resources reallocation.

1.3 Goals and Scope

In this research, we consider the individual contribution of surface water and groundwater resources in natural runoff. Local BWF is divided into two groups: agricultural BWF, and domestic plus industrial BWF. We do our assessment per province on a monthly scale and therefore, all data are collected per province per month. Our study period covers 35 years during 1981-2015. The following paragraphs describe the goals and scopes of this research, respectively.

1.3.1 Goals

The main idea of this research is to assess the availability and sustainability levels of Iran's limited blue water resources and then, propose proper BWCs to restrict unsustainable blue water consumption. We also try to figure out the implications of setting these caps on limiting the unsustainable BWF fractions.

Three research questions have been formulated to achieve the research goal:

1. How do monthly/annual EFRs and BWAs vary in different provinces and climatic regions?
2. Does current blue water consumption within different provinces and climatic regions violate estimated EFRs?
3. How to formulate monthly BWCs and address the implications of natural variability?

1.3.2 Scope

The monthly BWAs of surface water and groundwater are first assessed at the provincial scale and climate zone level. The BWA assessment is performed by two indicators: individual blue water scarcity (BWS) and violation rates of current BWF in EFRs for surface and groundwater resources. Many papers presented different indicators to quantify water scarcity. This research focuses more on blue water overuse and blue water resources vulnerability. BWS is estimated based on Hoekstra, Mekonnen, et al. (2012) by dividing BWF by BWA. The violation represents to what extent the EFR is violated by the current BWF. BWS is estimated on a monthly scale for surface water resources, and on annual scale for groundwater and total blue water resources. We select an annual scale for groundwater scarcity since the replenishment rate of groundwater is low and stable, and the groundwater availability is intrinsically at annual scale, which means considering annual groundwater scarcity is more meaningful in the research.

The options of setting BWCs depend on the annual demand fulfilment and surface water availability. Twelve scenarios were formulated. The blue water demand is considered to be equal to BWF per month per province in 1981-2015. Because demand is interannually variable, cap setting requires an exact reference. The research takes the year with the highest annual demand as the reference, and the BWC is represented as a certain demand fulfilment percentage of the demand for each month in the year with the highest demand in the study period. Maximum, average and minimum monthly surface water availabilities using six EFRs methods are also part of scenarios. These three options are set as monthly surface water caps (SWCs). And as the output of each scenario, the corresponding EFR_{SW}s violations at monthly scale as well as the EFR_{GW}s violations at annual scale are analyzed.

An overview of the scope of this study is shown in Table 1.

Table 1. Scope of this study

Scope settings	**This study**
Geographical scale	Provincial and climatic region level

Study period	Year 1981 to 2015
WF type	Blue
WF groups	Agriculture, industry and domestic
Data interval	Monthly
Sustainability indicators	BWS and EFR violation
Sustainability scale	Surface water: monthly; Groundwater: yearly
WF cap options	Twelve scenarios

1.4 Study Area

Iran is selected as a case study for this research; which is divided into 30 provinces, and includes 5 climatic regions (Figure 1). They are hyper-arid, arid, semi-arid, dry-sub humid and humid zone. As shown in Figure 1, only the top part of the country is sub-humid or humid, most of the western part is semi-arid, and for the central and eastern part, it becomes arid or hyper-arid. The annual precipitation of Iran is only 228 mm on average (AQUASTAT, 2016) and 75% of the precipitation falls when not needed by the agricultural sector. Winter is mostly wet while few parts of Iran receive rainfall in summer (Madani, 2014). This natural hydrological condition causes severe BWS in dry months. As for the distribution of precipitation from geographical perspective, the northern, western and southwestern regions cover only 30% of the total area of the country with more than 56% of the total rainfall. Conversely, with 70% of land area, the central and eastern parts of Iran only receive 43% of the total rainfall (Zehtabian et al., 2010). Therefore, most of the provinces in the arid to the hyper-arid zone are facing water scarcity problems, this may also result in unlimited groundwater abstraction. Setting caps for surface water and renewable groundwater is necessary to regulate the overdraft of blue water withdrawal and to raise public awareness of environmental protection.

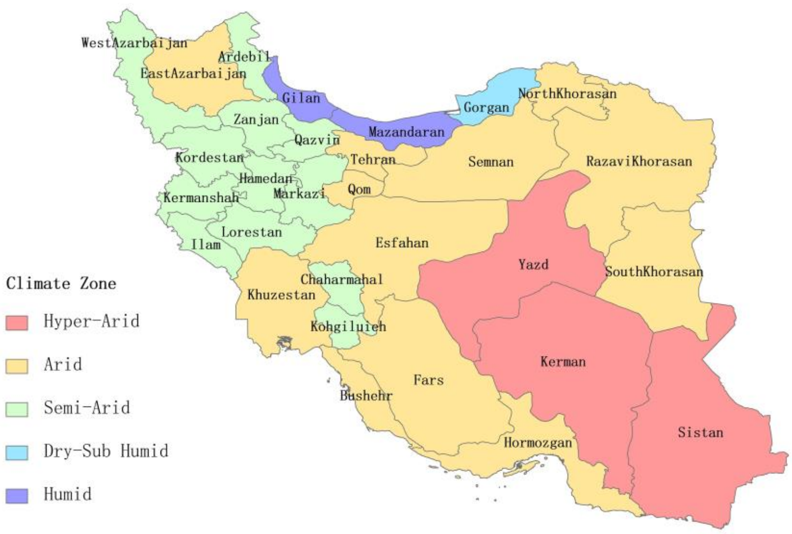


Figure 1. Map of provinces and climatic regions in Iran

1.5 Outline

This report goes into detail about the research that has been performed. First, a literature review is conducted in Chapter 2, which consists of earlier studies about EFR methods, blue water resources vulnerability and capping WF. The research gap is further addressed in this chapter. In Chapter 3, methods to answer research questions are given. Then the results for the current situation and for the blue WF options are presented in Chapter 4. Chapter 5 contains discussions of this research. Chapter 6 presents the major conclusion drawn from this research and the recommendations for further studies.

Chapter 2

Literature review

This chapter reviews some existing studies on the available EFR methods, blue water resources vulnerability and setting WF caps. This literature review will be a good guide to conduct the following research. Section 2.1 compares different EFR methods and chooses several EFR methods to apply in estimating EFRs for this research, then it reviews available studies on blue water resources vulnerability. Section 2.2 outlines the current studies about water footprint capping and clarifies the research gap that has to be filled by this study.

2.1 Literature Perspective on EFRs

Estimating EFRs is the preliminary step for further assessment. EFRs refer to the flows that ensure a flow regime capable of sustaining a complex set of aquatic habitats and ecosystem processes. In this study, EFRs are individually estimated for surface and groundwater resources. Here, the minimum stable groundwater runoff refers to the contribution of groundwater in EFRs.

2.1.1 EFR Methods for Surface Water

Several factors influence the amounts of EFRs when setting them for surface water resources, including the size of the river, its natural state and a combination of the desired state of the river. EFRs are influenced by various factors, which reflects that no simple figure can be given for the EFRs of rivers (Acreman et al., 2004). The approaches developed to define environmental flow allocations can be divided into five categories shown in Table 2 (Acreman et al., 2004; Dyson et al., 2003; Richter et al., 2012).

Table 2. EFR methods and their advantages/disadvantages

Categories of methods	Advantages / Strengths	Disadvantages / Limitations
Look-up tables	- Require relatively few hydrological and ecological resources - Cheap and fast	- Not taking account of site-specific conditions - Hydrological indices are not valid ecologically and ecological indices need region-specific data to be calculated
Desk-top tables	- Concern both flow and ecology factors	- Not include other factors such as water quality - Lack of data and time consuming - No explicit use of ecological data
Functional analysis	- Flexible and robust - More focus on the whole ecosystem	- Require interdisciplinarity - Expensive to collect these ecological data

Habitat modelling	- Replicable and predictive	- Expensive - May also lead to poor applications by practitioners with inadequate training
Holistic approaches	- Cover the whole hydrological-ecological-stakeholder system	- Complex - Expensive and time-consuming

The selecting of approaches to defining EFRs depends on different cases and situations. Generally, large scales such as determining general river health levels can use cheaper and faster methods like look-up tables or even desk-top tables. If the aim is impact assessment or river restoration, more complex methods should be selected as investments are necessary (Acreman et al., 2004). Acreman et al. (2004) recommended adopting look-up tables or desk-top tables methods for national audits.

Pastor et al. (2014) conducted EFRs assessment on a global scale. Only the hydrological methods were considered because of the lack of eco-hydrological data and these methods were defined with various ecological condition levels. The methods included Tennant method (Tennant, 1976), Smakhtin method (Smakhtin et al., 2004; Smakhtin et al., 2006) and Tessmann method (Tessmann, 1980). Each method had sources of literature that were tracked by the author. The paper also proposed a new method called variable monthly flow (VMF) method. According to the global assessment from (Pastor et al., 2014), Tennant method and Smakhtin method showed higher EFRs estimates than the local calculated EFRs. Tessmann method and VMF method showed the highest correlation with the local calculated EFRs.

Smakhtin et al. (2006) used the existing desktop EFR approaches to illustrate their applicability in Nepal. Tennant (Tennant, 1976) method showed its drawback of too simplistic and did not take into account the recent eco-hydrological theories; RVA (Range of variability approach) (Richter et al., 1997) method was too elaborate for national scales; DRM (Desktop reserve model) (Hughes et al., 2003) was developed for a specific country/region and it needed to be further tested and re-calibrated.

Richter et al. (2012) indicated the conflict between good intentions to define appropriate EFRs and the cost and time needed to define the EFRs. Therefore, they introduced a presumptive, risk-based environmental flow standard to provide interim protection for rivers.

Jägermeyr et al. (2017) used an adapted version of Tessmann (Tessmann, 1980) method to establish gridded process-based estimates of EFRs. This new method replaced the most restrictive parameter in Tessmann method that allocated 100% of river flow during low flow periods by 80%. It lowered the upper limit of EFRs in the dry period and made the regulation more realistic.

2.1.2 EFR Methods for Groundwater

There are only a few scholars studying the upper limits of groundwater withdrawal.

Gleeson et al. (2018) suggested a presumptive standard that groundwater pumping should decrease monthly natural baseflow by less than 10 percent through time to provide high levels of ecological protection. Although it could be regarded as a critical placeholder where detailed scientific assessments of environmental flow needs could not be undertaken, areas, where had already suffered severe water scarcity problems, required more specific and detailed caps on groundwater use.

Graaf et al. (2019) recently have presented a method that environmentally critical streamflow threshold could be estimated as the Q90 of monthly groundwater discharge applying a five-year window over the past five years. The Q90 has been used as a low-flow index and have indicated the groundwater discharge needed to sustain a minimal flow required for aquatic habitats; it means that for 90% of the months (that is, 54 of the 60 months in the five-year window) groundwater discharge is above low-flow condition.

JICA (2003) proposed a master plan for groundwater development, conservation and management for Bogotá Plain in Colombia with the target year of 2015. They recommended a safe yield for groundwater resources should be less than 60% of groundwater recharge, which corresponds to the highest rate (65%) of current groundwater use in Bogotá Plain.

The methods regarding the evaluation of the minimum stable groundwater runoff are currently limited. Moreover, the selection of methods for certain research needs to fit the available data. Therefore, for this study, an appropriate assumption is proposed, an estimating range is set and shown in Chapter 3 in detail.

2.1.3 Blue Water Resources Vulnerability

Different indices were proposed for estimating BWS. In this research, we focus on how to restrict overexploitation of regional water resources; hence, we reviewed literature in which BWS is estimated based on blue water withdrawal and consumption.

Raskin et al. (1997) introduced an indicator called "water resources vulnerability index" which was defined as the total annual withdrawals as a percent of available water resources. This indicator was an adapted one based on the assessment conducted by Shiklomanov (1991), it replaced water demand with water withdrawals to focus more on "use" but not "need" (Rijsberman, 2006).

Smakhtin (2004) proposed a water stress index by taking EFRs into account, which calculated the ratio of blue water withdrawal to BWA at an annual scale. The BWA was the difference between mean annual runoff and EFR. This indicator considered ecocentric perspective and calls for such space for environmental protecting.

Brauman et al. (2016) defined the water depletion index as the total water consumption divided by renewable blue water resources. The renewable blue water resource was the sum of surface runoff and groundwater recharge. They used WaterGAP3 model to simulate groundwater recharge as a fraction of the surface water runoff. And they finally recommended 0.75 as a threshold of having water depletion problems in regions.

The paper of Mekonnen, et al. (2012) conducted a more accurate assessment of global water scarcity. Similar to the paper of Brauman et al. (2016), this BWS indicator was based on blue water consumption instead of blue water withdrawal. It defined the BWS which was useful for this research, referring to the ratio of the BWF in one certain basin to the BWA. The latter one was also evaluated by subtracting EFRs from total blue water runoff. Same as Smakhtin (2004)'s indicator, the BWA also took the blue water for environmental needs into account.

Indeed, the selection of water scarcity indicators needs to be based on many factors, such as the goal of the research, the available data and the study scale. The evaluation of BWS helps to assess the current situation of the study area and to propose better suggestions for improving blue water use.

2.2 Literature Review on BWF Capping and Research Gap

Although setting caps on WF is still novel not only as a global topic but also as a policy instrument, it has been proposed by an increasing number of scholars and seen by many as a key step in the sustainable allocation of water resources (Quesne et al., 2010; Mekonnen et al., 2016).

The idea was firstly adopted in the Murray-Darling Basin in Australia. First, the Ministerial Council agreed that the cap can be defined as: "the volume of water that would have been diverted under 1993/94 levels of development". And it was adjusted for certain developments that occurred after 1993/94 for the reason of equity: 1. Cap diversions at 1993/94 levels for New South Wales, Victoria and South Australia; 2. Audited WAMP/WRP process (an independently audited Water Allocation Management Planning process) to determine Cap for Queensland (MDBC, 2004). This measure limited surface water diversions to a long-term mean of 12,100 GL per year, then seasonal adjustments were made for wet and dry years. However, the cap was only introduced on diversions of surface water use from the basin and it did not take EFRs into consideration.

Zhuo et al. (2019) did the pioneering research on investigating the role of reservoir storage in defining the BWC and assessing the effect of water reservoirs regarding the variability of BWS in the Yellow River Basin. The effect of reservoirs on increasing dry-season BWA is the largest, while the reservoir storage increases BWS in wet months by storing excessive water in most rainy months. However, this study only focused on one basin in China, and did not consider several issues such as the role of inter-annual variabilities in cap values for each month. Moreover, the study applied only one methodology to determine the EFR and took 80% of natural runoff as EFR without considering the uncertainties of estimating EFR.

Hogeboom et al. (2020) did a global assessment of setting monthly blue WF caps on world's river basins and added to the contemporary discourse on a Planetary Boundary for freshwater consumption. Their research addressed some implications of temporal variability and quantified trade-offs between violating EFRs and underutilizing available flow based on three different options of setting monthly WF caps. A large uncertainty was found to remain when estimating runoff and EFRs by simply taking the average of the results of three alternative global hydrological models (GHMs) and three EFR methods during a historical period. And it is important to also address the inter-annual and intra-annual natural variability. The potential trap is that limits are set for an average year, which will inevitably lead to problems in drier years (Hoekstra, 2014). Local and time-specific blue WF caps are required according to the conclusion of this global study.

An important issue not addressing by the earlier researchers yet is setting caps on groundwater consumption. One of the shortcomings of Murray-Darling Basin case is neglecting caps on groundwater use. The caps on surface water use may accelerate groundwater abstraction instead, which made the conditions of aquifers even worse. Various papers were published regarding groundwater withdrawal estimation and regulation. For instance, Wada et al. (2014a) provided a table of model-based simulating results of global groundwater withdrawal, which remained a large range from 545 billion m^3/year (Siebert et al., 2010) to 1708 billion m^3/year (Wisser et al., 2010). However, local assessments are still required, and the caps on groundwater resources consumption need to be established.

Setting a cap for BWF can be one of the effective water policy measures to prevent overexploitation of limited freshwater resources and to reconcile human freshwater appropriation with conservation (Hoekstra, 2019; Hoekstra et al., 2014; Hogeboom et al., 2020).

Chapter 3

Methodology

This chapter gives a description of the data and the method used to fulfill the proposed research objective and answer research questions. Section 3.1 provides an overview of the available dataset. Section 3.2 describes the approaches of evaluating monthly BWA levels. After this, the methods of assessing the levels of sustainability are presented in Section 3.3. And finally, the blue WF cap options are shown in Section 3.4.

3.1 Data

The initial data source in this research is from Water Resource Management Organization of Iran (IWRM). The data covers the period of 1981 to 2015 which contain monthly total natural runoff at the provincial scale. For each year, natural runoff is classified into surface water and groundwater. Note that there is a gap in data between 2010 and 2015, all the natural runoff data is missing in year 2011, 2012, 2013 and 2014. In order to make the up-to-date analysis, this study includes the analysis regarding year 2015's data and considers data in 2015 as the average of 2010-2015.

The current blue water consumption data of each province and each climate zone is also available to evaluate the BWF with distinguishing agricultural BWF, domestic and industrial blue water withdrawal. Among these, the agricultural BWF is provided as monthly scale, while the domestic and industrial BWF are at yearly scale. The period of BWF data is the same as the data of natural runoff.

3.2 Evaluating Monthly BWA levels

The starting point is to estimate monthly BWA levels which can be split into surface water and renewable groundwater resources. The estimations are based on two principles, which are shown in Equation 3.1 and Equation 3.2 (Gleeson et al., 2012; Hoekstra, 2019). As previous sentences indicated, both the estimations of surface water availability and groundwater availability require a vital step which is estimating the individual contributions of surface water and groundwater resources in EFRs. Therefore, there is a need to estimate EFRs in an appropriate way.

$$BWA_{SW}[m,i] = BWR_{SW}[m,i] - EFR_{SW}[m,i] \tag{3.1}$$

where *m* is month, *i* is province (or climate zone), BWA_{SW}[m,i] is the surface water availability for each month and each province (or climate zone) (m^3/m), BWR_{SW}[m,p] is the locally generated direct runoff for each month and each province (or climate zone) and EFR_{SW}[m,i] is the surface water contribution in EFRs for each month and province (or climate zone).

$$BWA_{GW}[y,i] = GW\ Recharge[y,i] \ - EFR_{GW}[y,i] \tag{3.2}$$

where y is year, i is province (or climate zone), BWA_{GW}[y,i] is the groundwater availability for each year and province (or climate zone) (m^3/y), GW Recharge[y,i] refers to the groundwater recharge for each year and each province (or climate zone), and EFR_{GW}[y,i] is the renewable groundwater contribution in EFRs for each year and province (or climate zone).

3.2.1 Surface Water

According to the literature review in Chapter 2 and the available input data in Iran, in this research, only hydrological methods are used for estimating EFRs on surface water resources due to the lack of hydraulic and ecological data at the national scale. Six existing environmental flow methods are selected, including the Tennant method (Tennant, 1976), the Smakhtin method (Smakhtin et al., 2004), the Richter method (Richter et al., 2012), the Tessmann method (Tessmann, 1980), the adapted Tessmann method (Jägermeyr et al., 2017) and the VMF method (Pastor et al., 2014).

- **Richter method:** In this method, the type of flow regimes is not considered. It assumes a presumptive EFR standard, which takes EFR to be as a constant percentage (80%) of natural river flow.

- **Smakhtin method:** The Smakhtin method estimates the EFR by adding together the high flow requirement (HFR) and the low flow requirement (LFR). LFR equals a base flow volume of 90th percentile (Q90) of BWR. HFR is determined by comparing Q90 with a certain percentage of mean annual flow (MAF). Three groups of HFR are listed below with 20% MAF, 15% MAF and 7% MAF respectively for highly variable flow regimes. And HFR = 0 indicates the very stable flow regimes.

$$EFR_{Smakhtin} = LFR + HFR \tag{3.3}$$

where LFR is the low flow requirement, in this method, LFR equals Q90, which is defined as the monthly flow that is exceeded 90% of the time. Q90 mostly falls between 0 and 50% of MAF. HFR is the high flow requirement, Table 3 contains the corresponding values of HFR in different conditions comparing with Q90.

Table 3. High flow requirement (HFR) of Smakhtin method

Highly variable flow regimes	Q90 ≤ 10% MAF	HFR = 20% MAF
	10% MAF < Q90 ≤ 20% MAF	HFR = 15% MAF
	20% MAF < Q90 ≤ 30% MAF	HFR = 7% MAF

Very stable flow regimes	30% MAF < Q90	HFR = 0

- **Tennant method:** This method divides a year into two periods, which are the wet period and dry period. Based on the local information, the wet period in Iran occurs over the period October-March, and the dry period occurs over the period April-September. In Tennant's method, the flow conditions which range from fair to outstanding are considered as moderate habitat for fish and the average percentages of possible ranges in two different periods are used in this research. Therefore, in the wet period, the recommended minimum flow is specified as 45% (with a range from 30% to 60%) of MAF; in the dry period, the base flow is considered as 25% (with a range from 10% to 40%) of MAF.

- **Tessmann method:** Tessmann method is a modification of the Tennant method. Tessmann divides a hydrological year into 12 monthly periods and classifies them into one of three categories, defined by the ratio of mean monthly flow (MMF) to mean annual flow (MAF).

Table 4. Three categories of mean monthly flow (Tessmann method)

Category	**Recommended mean monthly flow**
MMF ≤ 0.4MAF	MMF
MMF > 0.4MAF and MMF ≤ MAF	0.4MAF
MMF > MAF	0.4MMF

- **Adapted Tessmann method:** The adapted Tessmann method replaces the most restrictive parameter that allocates 100% of river flow during low flow period by 80% of river flow, which was proposed by B. D. Richter et al. (2012).

- **VMF method:** VMF method distinguishes high, intermediate and low flow regimes, then allocates 30% to 60% of blue water runoff (here refers to surface water) to the environment. The detailed VMF method is explained in Equation 3.4.

$$\begin{cases} EFR_{i,m} = 0.6 * MMF_{i,m} \quad given\ that\ MMF_{i,m} \leq 0.4 * MAF_i \\ EFR_{i,m} = 0.45 * MMF_{i,m} \quad given\ that\ 0.4 * MAF_i < MMF_{i,m} \leq 0.8 * MAF_i \\ EFR_{i,m} = 0.3 * MMF_{i,m} \quad given\ that\ MMF_{i,m} > 0.8 * MAF_i \end{cases} \tag{3.4}$$

where $EFR_{i,m}$ are the environmental flow requirements of province (or climate zone) i and month m, MAF_i is the mean annual flow of province (or climate zone) i, and $MMF_{i,m}$ is the mean monthly flow of province (or climate zone) i and month m.

3.2.2 Groundwater

Groundwater and stream flow constitute a dynamic system which makes it difficult to evaluate groundwater recharge and minimum stable groundwater runoff. The most important methods available for estimating groundwater recharge can be categorized as follows: direct measurements, water balance methods, hydrological models and tracer methods. In this research, the data of groundwater discharge at monthly scale between the study period is already provided. The groundwater recharge is assumed to be equal to the groundwater discharge.

As for the evaluation of minimum stable groundwater runoff at annual scale, which also refers to groundwater contribution in EFRs (EFR_{GW}), the study follows the method suggested in T Gleeson et al. (2018)'s paper as the most conservative method to estimate EFR_{GW}, which is taking 90% of the baseflow as environmental protection. Taking 60% of groundwater recharge as the groundwater contribution in EFRs is the loosest method in this study, which is referenced from (JICA, 2003). These two methods are considered as the highest boundary and the lowest boundary of EFR_{GW}. To help the further research on setting caps, two groundwater's estimating methods are newly added by taking 80% and 70% of groundwater recharge as the minimum stable groundwater runoff. Therefore, four groundwater EFR methods will be applied in this study by taking 90%, 80%, 70% and 60% of groundwater recharge as EFR_{GW} respectively.

$$EFR_{GW}[y,i] = m\% * GW\ Recharge[y,i] \qquad (3.5)$$

where y is year, i is province (or climate zone), m% equals to 90% (or 80%,70%,60%), $EFR_{GW}[y,i]$ refers to the renewable groundwater contribution in EFRs for each year and province (or climate zone) and GW Recharge[y,i] refers to the groundwater recharge for each year and each province (or climate zone).

The range of resulting EFRs using different methods can be proposed for both surface water and groundwater resources. Note that there are possibilities that the natural runoff even cannot meet the minimum value of basic environmental needs in certain months of a specific year (normally in some months in the dry period), which means that the value of BWA is negative. Considering this kind of situation, the BWA is set to zero when comparing EFRs with BWA.

3.3 Assessing Blue Water Sustainability levels

This section is to introduce the approaches used to assess the current blue water sustainability levels. Two indicators are designed to assess the sustainability, BWS and the rate of EFR violations under current conditions.

3.3.1 Blue Water Scarcity

The BWS is defined as the ratio of the blue WF to the BWA at the same scale according to Mekonnen, et al. (2012). Equation 3.6 is the mathematic presentation of this definition. A BWS equals one means that the available blue water has been fully consumed. It can be classified into four groups, low (BWS < 1.0), moderate (1.0 < BWS < 1.5), significant (1.5 < BWS < 2.0) and severe (BWS > 2.0). This classification method is referenced from Mekonnen et al. (2016). To clearly see the current situation and the changes during the study period, the number of months in which surface water scarcity exceeds 1.0 and the number of years in which surface water / groundwater / total blue water scarcity exceeds 1.0 are also counted. The number of months in which surface water scarcity exceeds 1.0 is calculated based on the averaged-year monthly surface water scarcity.

$$SWS[m,i] = BWF_{SW}[m,i] \,/\, BWA_{SW}\,[m,i]$$
$$GWS[y,i] = BWF_{GW}[y,i] \,/\, BWA_{GW}\,[y,i] \tag{3.6}$$

where m is month, y is year, i is province (or climate zone), SWS[m,i] refers to surface water scarcity for each month and province (or climate zone), BWF_{SW}[m,i] refers to surface water footprint for each month and province (or climate zone), BWA_{SW}[m,i] refers to the surface water availability for each month and each province (or climate zone), GWS[y,i] refers to groundwater scarcity for each year and province (or climate zone), BWF_{GW}[y,i] refers to groundwater footprint for each year and province (or climate zone) and BWA_{GW}[y,i] refers to the groundwater availability for each year and each province (or climate zone).

The BWS varies intra-annually and inter-annually. This study assesses SWS per province (or climate zone) per month, while assesses GWS per province (or climate zone) per year. The total blue water scarcity is calculated as the ratio of annual blue WF to the sum of annual SWA and GWA using each EFR method. Both annual blue WF and annual BWA are summed by each month's value of each year. Moreover, to address the inter-annual variation of scarcity and to incorporate the climate change, 10-year averaged BWS is calculated for the period of the year 1981 to 2015. Because the total period is 35 years, the last five years are considered as the results of the year 2015, and it has been presented to compare with the previous three decades' results. The spatial variation and the temporal variation are both considered which are presented in Chapter 4. And there are also comparisons among different method's results or different combination's results in the next chapter.

3.3.2 Violation of Current Blue WF in EFRs

The rate of EFR violations is also assessed to see to what extent EFRs are violated by the current blue WF. It has been the second indicator that evaluating the sustainable level of current blue WF. The violation consists of three categories, which are the total violation, agricultural violation and domestic and industrial violation. The agricultural violation refers to the contribution of agriculture in total EFR violation; The domestic and industrial violation means the contribution of domestic and industry sector in the total EFR violation. The violation is calculated as EFR minus the remained blue water then divided by the remained blue water. The remained blue water is the subtraction of BWR and BWF. The evaluation is based on the following equations.

$$SWV[m,i] = \frac{EFR_{SW}\ [m,i] - (BWR_{SW}\ [m,i] - BWF_{SW}\ [m,i])}{BWR_{SW}\ [m,i] - BWF_{SW}\ [m,i]}$$

$$GWV[y,i] = \frac{EFR_{GW}\ [y,i] - (\ BWR_{GW}\ [y,i] - BWF_{GW}\ [y,i])}{BWR_{GW}\ [y,i] - BWF_{GW}\ [y,i]} \qquad (3.7)$$

In Equation 3.7, m is month, y is year, i is province (or climate zone), SWV[m,i] refers to the rate of EFR_{SW} violation by surface water footprint for each month and province (or climate zone), BWR_{SW}[m,i] refers to the locally generated direct runoff for each month and each province (or climate zone), BWF_{SW}[m,i] refers to surface water footprint for each month and province (or climate zone), GWV[y,i] refers to the rate of EFR_{GW} violation by groundwater footprint for each year and province (or climate zone), BWR_{GW}[y,i] refers to the groundwater discharge for each year and each province (or climate zone) and BWF_{GW}[y,i] refers to groundwater footprint for each year and province (or climate zone).

$$SWV_{Agr}[m,i] = \frac{BWF_{SW-Agr}[m,i]}{BWF_{SW}\ [m,i]} * SWV[m,i]$$

$$GWV_{Agr}[y,i] = \frac{BWF_{GW-Agr}[y,i]}{BWF_{GW}\ [y,i]} * GWV[y,i] \qquad (3.8)$$

$$SWV_{DI}[m,i] = \frac{BWF_{SW-DI}[m,i]}{BWF_{SW}\ [m,i]} * SWV[m,i]$$

$$GWV_{DI}[y,i] = \frac{BWF_{GW-DI}[y,i]}{BWF_{GW}\ [y,i]} * GWV[y,i] \qquad (3.9)$$

where SWV_{Agr}[m,i] refers to the rate of EFR_{SW} violation by surface water footprint which consumed by agriculture sector for each month and province (or climate zone), BWF_{SW-Agr}[m,i] refers to surface water footprint consumed by agriculture sector for each month and province (or climate zone), BWF_{SW}[m,i] refers to surface water footprint for each month and province (or climate zone), GWV_{Agr}[y,i] refers to the rate of EFR_{GW} violation by groundwater footprint which consumed by agriculture sector for each year and province (or climate zone), BWF_{GW-Agr}[y,i] refers to groundwater footprint consumed by agriculture sector for each year and province (or climate zone) and BWF_{GW}[y,i] refers to groundwater footprint for each year and province (or climate zone).

where SWV_{DI}[m,i] refers to the rate of EFR_{SW} violation by surface water footprint which consumed by domestic and industrial sector for each month and province (or climate zone), BWF_{SW-DI}[m,i] refers to surface water footprint consumed by domestic and industrial sector for each month and province (or climate zone), BWF_{SW}[m,i] refers to surface water footprint for each month and province (or climate zone), GWV_{DI}[y,i] refers to the rate of EFR_{GW} violation by groundwater footprint which consumed by domestic and industrial sector for each year and province (or climate zone), BWF_{GW-DI}[y,i] refers to groundwater footprint consumed by domestic and industrial sector for each year and province (or climate zone) and $BWF_{GW}[y,i]$ refers to groundwater footprint for each year and province (or climate zone).

In Equation 3.8, the ratio of the agricultural contribution in BWF to the total BWF consumed by different sectors is firstly calculated. This ratio multiplies the total violation of total blue WF in EFRs giving the agriculture sector's contribution in total violation. In Equation 3.9, the same principle is followed as in Equation 3.8, which gives the domestic and industrial sectors' EFR violations.

Similar to the considered scale in BWS evaluation, surface water violations are assessed per month per province (or climate zone), while the groundwater and total blue water violations are assessed per year per province (or climate zone). The rate of EFR violations in groundwater and total blue water also addresses the inter-annual variation; the intra-annual variation is presented based on the EFR violations in surface water resources. The maximum, minimum and average results calculated by different methods are presented in the following chapter.

3.4 Establishing blue WF cap options

After analyzing the current sustainability levels, the next step is to establish monthly BWCs options per province (or climatic zone). The scenario is formulated by two parts, one is the annual demand fulfilment and the other one is monthly SWC. The outputs of each cap option are under-fulfilment of demand (UFD), EFR_{SW} and EFR_{GW} violation. An overview of establishing BWCs options and the contents of outputs is shown in Figure 2.

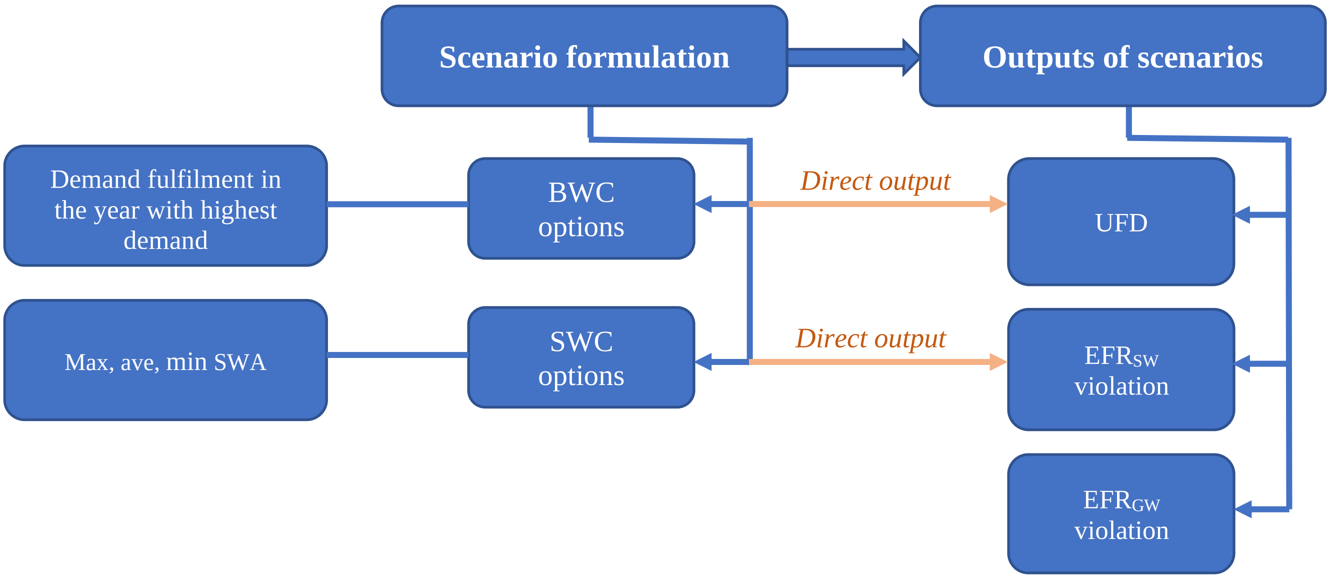


Figure 2. Overview of scenarios formulation and outputs of scenarios

3.4.1 Scenario formulation

This research formulates twelve scenarios in total. The demand fulfilment is the first part of the scenario. Due to the variability of annual demand, there is a need to set a benchmark of demand. This study takes monthly demand in the year with the highest demand (BWF_max) as the benchmark, and the demand fulfilment is the certain percentage of BWF_max. This certain percentage here is the fulfilment level in the year with the highest demand. Four demand fulfilment levels (DFLs) are decided to analyze, 100%, 85%, 75% and 60% respectively. This research takes demand fulfilments as BWCs options, therefore the value of each total blue water footprint cap (BWC) is the product of demand fulfilment percentage and demand for each month in the year with the highest demand.

$$BWC[m,i] = x\% * BWF\_\text{max}\ [m,i] \quad (3.10)$$

where BWC[m,i] is the value of total blue water footprint cap for province (or climate zone) *i* and month *m*, x% is the demand fulfilment level in the year with the highest demand (four demand fulfilment levels are formulated, x% = 100%, 85%, 75% or 60%), BWF_max[m,i] is the demand (here blue water footprint is considered as the blue water demand) of province (or climate zone) *i* for month *m* in the year with the highest demand.

To specifically differentiate surface water and groundwater cap, the study takes three options of monthly SWC for each DFL, which are maximum, average and minimum monthly BWA_{SW} analyzed by six EFR methods. In this way, the SWC is distinguished from groundwater. Therefore, four DFLs form the four main scenarios, and each main scenario consists of three options of monthly SWC. There are twelve specific scenarios in total. And the EFR_{GW} violation becomes the output of scenarios. Table 5 is an overview of each scenario formulated in this research.

Table 5. An overview of each scenario

Scenario A	Scenario A1	100% DFL + max BWA_{SW}
	Scenario A2	100% DFL + ave BWA_{SW}
	Scenario A3	100% DFL + min BWA_{SW}
Scenario B	Scenario B1	85% DFL + max BWA_{SW}
	Scenario B2	85% DFL + ave BWA_{SW}
	Scenario B3	85% DFL + min BWA_{SW}
Scenario C	Scenario C1	75% DFL + max BWA_{SW}
	Scenario C2	75% DFL + ave BWA_{SW}
	Scenario C3	75% DFL + min BWA_{SW}
Scenario D	Scenario D1	60% DFL + max BWA_{SW}
	Scenario D2	60% DFL + ave BWA_{SW}
	Scenario D3	60% DFL + min BWA_{SW}

3.4.2 Outputs of the scenarios

Based on the considered DFLs, we can estimate the level of supply and consequently, underfill demand per province (or per climatic zone) per year. The actual supply of provinces or climate zones per month is calculated by taking the minimum value of BWC for each month and the actual demand (BWF) for each month. Meanwhile, the UFD can be known by subtracting the actual supply from the actual demand (BWF) per province (or climatic zone) per month. The annual UFD level will be represented as a percentage, which is calculated as the annual UFD divided by the annual BWF.

$$Actual\ Supply[(y,m),i] = \min\ (BWC[m,i], BWF[(y,m),i]) \tag{3.11}$$

where BWC[m,i] is the value of total blue water footprint cap for province (or climate zone) *i* and month *m*. BWF[(y,m),i] represents the total blue water footprint of province (or climate zone) *i* in year *y* and month *m* according to the provided data.

$$UFD[(y,m),i] = BWF[(y,m),i] - Actual\ Supply[(y,m),i] \tag{3.12}$$

$$Annual\ UFD\ level[i] = ave\ \left(\frac{Actual\ annual\ BWF[y,i] - Actual\ annual\ supply[y,i]}{Actual\ annual\ BWF[y,i]}\right) \tag{3.13}$$

where UFD[(y,m),i] refers to the under fulfilment of demand of province (or climate zone) *i* in year *y* and month *m*, BWF[(y,m),i] and Actual supply[(y,m),i] refer to total blue water footprint and actual total blue water supply under the corresponding cap for province (or climate zone) *i* in year *y* and month *m* respectively.

where Annual UFD level[i] refers to the averaged value of the proportion of annual under fulfilment of demand in the actual annual blue water footprint in each year for province (or climate zone) *i*. Annual under fulfilment of demand refers to the summation of under fulfilment of demand in each month in year *y* of province (or climate zone) *i*, Actual annual BWF [y,i] and Actual annual supply[y,i] refer to the summation of total blue water footprint and actual total blue water supply under the corresponding cap for province (or climate zone) *i* in each month in year *y* respectively.

Three options of SWC are set for all main scenarios, the corresponding EFR_{SW} violation can be analyzed for each option. The EFR_{SW} violation is only influenced by SWC options, here the DFL has effects on the total BWC but does not directly influence the EFR_{SW} violation.

$$Annual\ violated\ volume[i] = Annual\ EFR_{SW}[y,i] - (Annual\ BWR_{SW}[y,i] - Annual\ BWC_{SW}[y,i]) \tag{3.14}$$

$$Monthly\ EFR_{SW}\ violation[m,i] = ave\ \left[\frac{EFR_{SW}[(y,m),i] - (BWR_{SW}[(y,m),i] - SWC[(y,m),i])}{BWR_{SW}[(y,m),i] - SWC[(y,m),i]}\right]) \tag{3.15}$$

where Annual violated volume[i] refers to the averaged-year value of EFR_{SW} that will be violated of province (or climate zone) *i* by taking max, ave, min surface water cap options, Annual EFR_{SW}[y,i] refers to the volume of environmental flow requirements using six EFR methods of province (or climate zone) *i* in year *y*, Annual BWR_{SW}[y,i] refers to annual surface runoff of province (or climate zone) *i* in year *y*, and Annual SWC[y,i] refers to annual surface water cap of province (or climate zone) *i* in year *y*. (Equation 3.14)

In Equation 3.15, Monthly violation[m,i] refers to the averaged-year value of EFR_{SW} violation of province (or climate zone) *i* in month *m* using different surface water cap option. EFR_{SW}[(y,m),i] refers to the volume of environmental flow requirements using six EFR methods of province (or climate zone) *i* in year *y* and month *m*, BWR_{SW}[(y,m),i] refers to surface runoff of province (or climate zone) *i* in year *y* and month *m*, and SWC[(y,m),i] refers to surface water cap of province (or climate zone) *i* in year *y* and month *m*.

The corresponding EFR_{GW} violation can be calculated according to formulated scenarios and BWA_{GW} estimated by four EFR_{GW} methods. Groundwater cap (GWC) for each month can be known by subtracting SWC from BWC (Equation 3.16). The EFR_{GW} violation at annual scale is analyzed in this study using Equation 3.18.

$$GWC[m,i] = BWC[m,i] - SWC[m,i] \quad (3.16)$$

$$Actual\ GW\ use[(y,m),i] = Actual\ supply[(y,m),i] - SWC[(y,m),i] \quad (3.17)$$

$$Annual\ EFR_{GW}\ violation[i] = ave\left[\frac{EFR_{GW}[(y,m),i] - (BWR_{GW}[(y,m),i] - Actual\ GW\ use[(y,m),i])}{BWR_{GW}[(y,m),i] - Actual\ GW\ use[(y,m),i]}\right] \quad (3.18)$$

where GWC[m,i] refers to monthly groundwater footprint cap of province (or climate zone) *i* in month *m*, BWC[m,i] refers to monthly total blue water footprint cap of province (or climate zone) *i* in month *m*, SWC[m,i] refers to monthly surface water footprint cap of province (or climate zone) *i* in month *m*. (Equation 3.16)

where Actual GW use [(y,m),i] refers to actual groundwater use under certain scenarios of province (or climate zone) *i* in year *y* and month *m*, Actual supply[(y,m),i] refers to the actual total blue water supply of province (or climate zone) *i* in year *y* and month *m*, SWC[(y,m),i] refers to surface water cap of province (or climate zone) *i* in year *y* and month *m* and Annual EFR_{GW} violation[i] refers to the rate of EFR violated by groundwater footprint under certain scenarios of province (or climate zone) *i*. (Equation 3.17 & Equation 3.18)

Chapter 4

Results

In this chapter, the results of the research questions are given. Section 4.1 describes the monthly BWA levels for surface water and groundwater resources. Section 4.2 presents the spatial and temporal variation of the current sustainable level for BWF. Finally, the results of different scenarios designed for BWF caps are shown in Section 4.3.

4.1 Monthly Blue Water Availability Levels

Fig. 3 shows the comparison between the estimation of monthly BWA_{SW} and monthly EFR_{SW} in Iran over the period of 1981-2015. The averaging monthly BWR_{SW} during the study period ranged from approximately 2×10^9 m^3 (in September) to 15×10^9 m^3 (in March). The amount of BWR_{SW} in the wet period (October-March) almost doubled the total amount in the dry period (April-September). In general, the averaging annual EFR_{SW} accounts for 53% of annual BWR_{SW} and the annual BWA_{SW} contributes 47% of annual BWR_{SW}. The monthly BWA_{SW} was quite low from July to October, which was maximumly 1.3×10^9 m^3 per month, since the BWR_{SW} was lower than it in other months and most of the methods addressed almost 80% to even nearly 100% of BWR_{SW} as EFRs. Among the six EFR methods, the Richter method and the Smakhtin method are the two most conservative methods, allocating about 80% of BWR_{SW} as EFRs in the wet period. The difference between these two methods is that Smakhtin method allocates more surface water resources as EFR_{SW}s in August, September and October even with more than 100%. The Tennant method allocates a larger percentage of BWR_{SW} as EFR_{SW}s in months with lower BWR_{SW}. It allocates 100% BWR_{SW} as EFR_{SW}s from August to October, while allocates only 25% as EFRs from January to May.

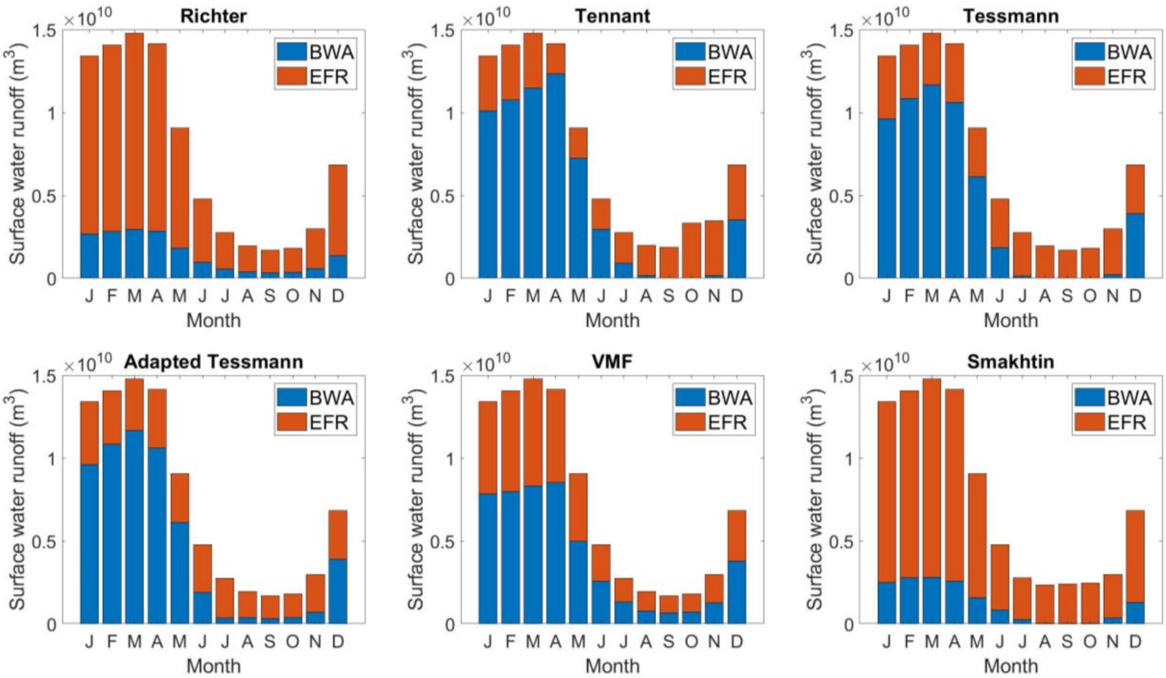


Figure 3. The comparison of monthly BWA_{SW} versus EFR_{SW} of Iran using six EFR_{SW} methods in the period of 1981 to 2015

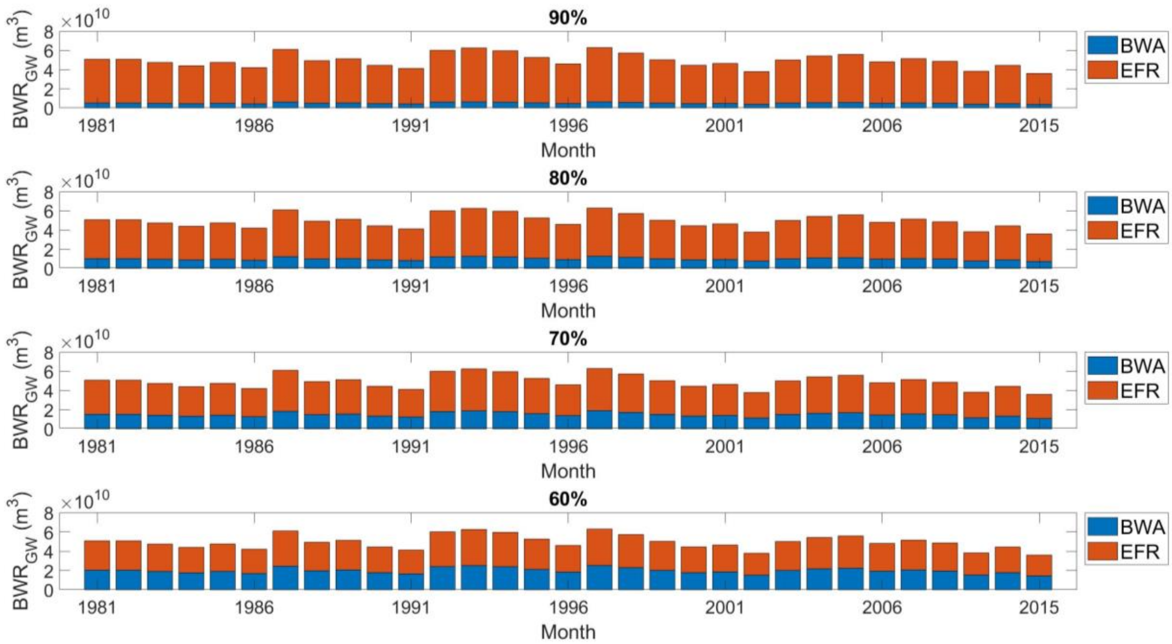


Figure 4. The comparison of annual BWA_{GW} versus EFR_{GW} of Iran using four EFR_{GW} methods in the period of 1981 to 2015

Figure 4 shows the annual BWA_{GW} versus annual EFR_{GW} in 1981-2015. The annual groundwater recharge ranged from about 4×10^{10} m^3 to 6×10^{10} m^3. The loosest method addressed about 3×10^{10} m^3 as EFR_{GW} per year on average, which allocates 60% of groundwater recharge as EFR_{GW}, while the strictest method addressed about 4.5×10^{10} m^3.

4.2 Current Sustainable Level of Blue WF

The current sustainability level of blue WF is evaluated using two indicators: BWS and violation of EFRs by BWF. For the presentation, spatial variation and temporal variation of BWS are shown in this section, followed by the temporal variation of total violation (also with the agricultural contribution in violation, the domestic and industrial contribution in violation).

4.2.1 Blue Water Scarcity

- **Spatial Variation**

Figure 5 shows the 10-year averaged monthly SWS in the study period to address the inter-annual variation of scarcity. SWS value is presented by taking the average value of the results by six EFR_{SW} methods. This figure shows an obvious increase in such scarcity over the study period. 9 provinces' SWS remained under unity (SWS<1) during the 1981-1990 period, while only 4 of them were out of such scarcity over the period of 2011-2015. In other words, the number of hotspots of surface water resources in Iran increased from 21 to 26 during the study period. A province is labeled as a hotspot if the BWS exceeds 1.0 (Hoekstra, 2019). According to Figure 5, most of the provinces in the hyper-arid and arid zone have faced severe surface water scarcity problems in recent years. The number of provinces that were facing severe surface water scarcity increased from 15 (in 1981-1990) to 21 (in 2011-2015).

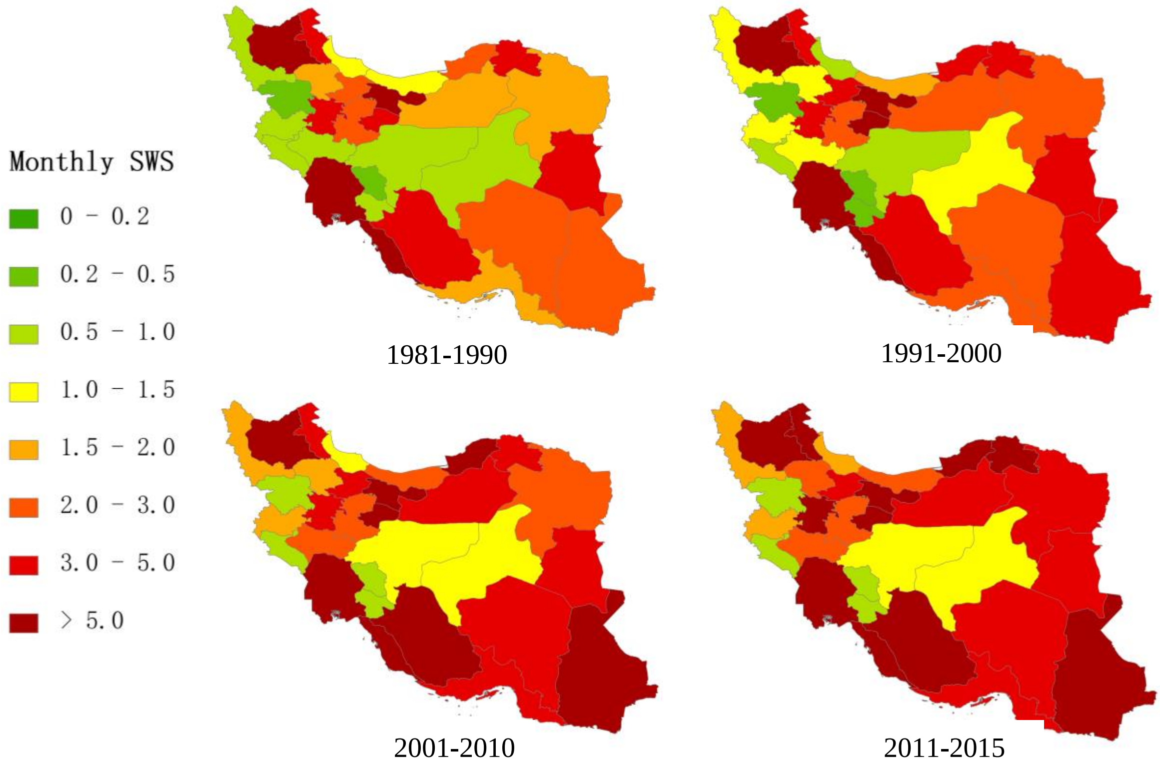


Figure 5. 10-year averaged monthly surface water scarcity in the period of 1981 to 2015 (monthly SWS value is an average value of the results calculated by six EFR_{SW} methods. Monthly SWS is categorized into 8 kinds of colors in the figure to clearly show the difference. Mainly the surface water scarcity is classified into four groups: low (SWS < 1.0), moderate (1.0 < SWS < 1.5), significant (1.5 < SWS < 2.0) and severe (SWS > 2.0), when SWS>=1.0, the province becomes a hotspot.)

Figure 6 shows the average-year of the number of months per year where SWS exceeds 1.0 and 2.0. None of the provinces were with all months' SWS values under 1.0 and Tehran as the province of the arid zone even faced the SWS over the whole year. There were only three provinces (Kordestan, Chaharmahal and Kohgiluieh) where SWS was not exceeding 2.0 in the whole year, other provinces were more or less facing severe surface water scarcity in the year.

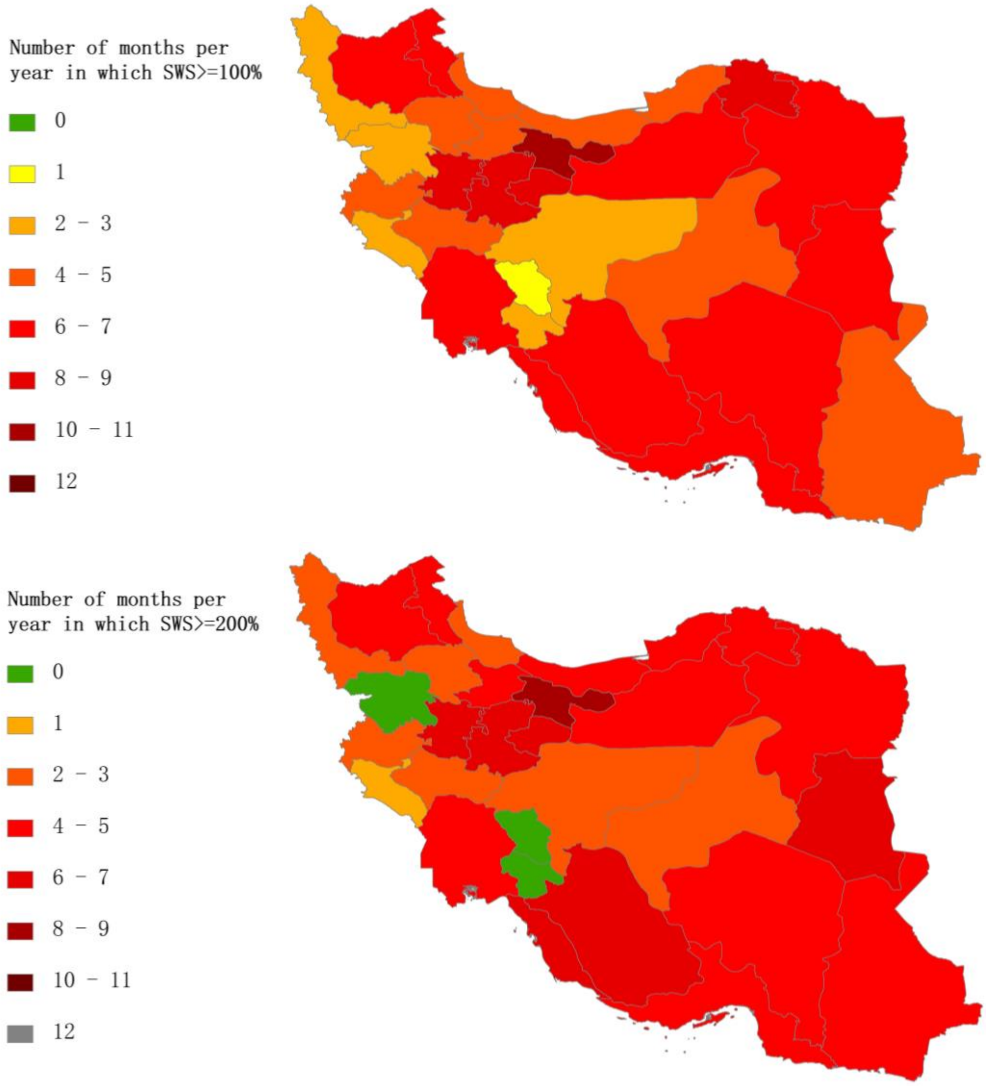


Figure 6. Number of months per year in which surface water scarcity exceeds 100% and 200%

Figure 7 presents the 10-year averaged annual GWS in the study period. Hotspots of groundwater consumption increased from 21 to 27 provinces during the period of 1981-2015. What can be seen is that almost all of the provinces in hyper-arid and arid climate regions suffered from severe groundwater scarcity in 2011-2015. Most of the provinces located within the semi-arid zone faced severe groundwater scarcity in 2011-2015 only except Kermanshah, Ilam, Chaharmahal and Kohgiluieh.

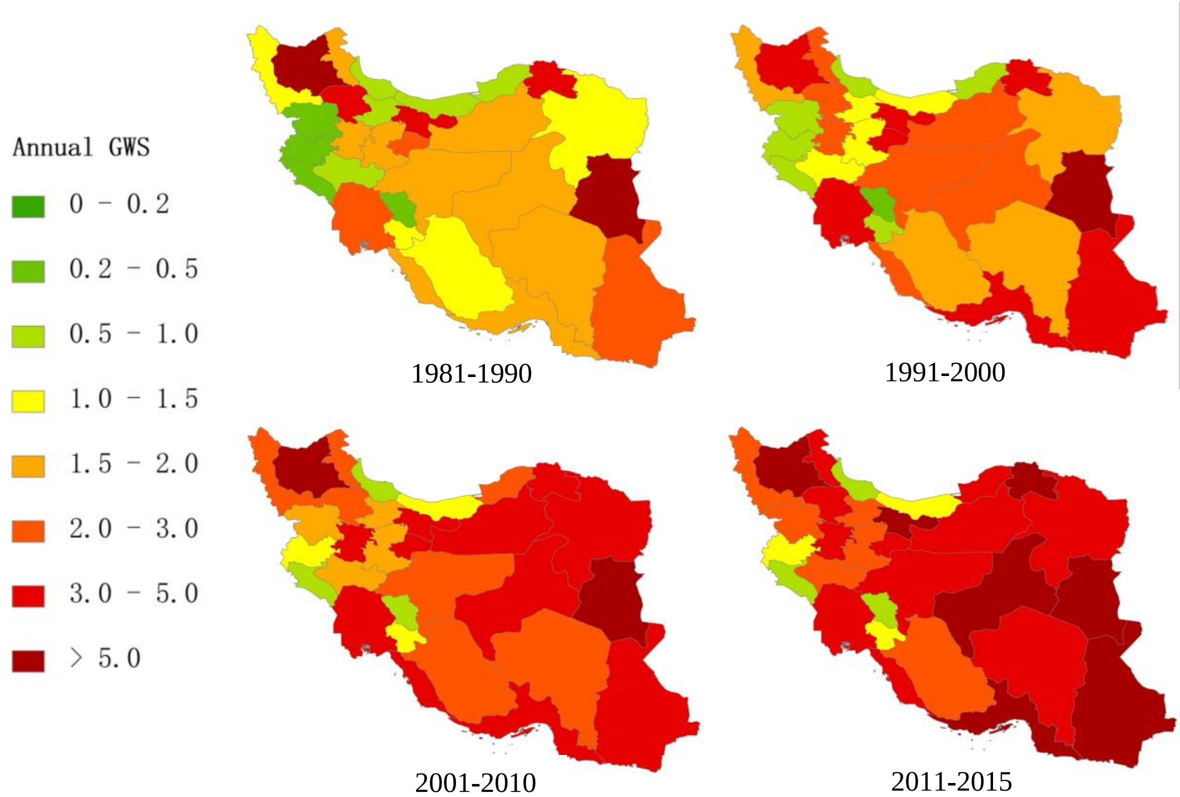


Figure 7. 10-year averaged annual groundwater scarcity in the period of 1981 to 2015 (annual GWS value is an average value of the results calculated by four EFRGW methods. Annual GWS is categorized into 8 kinds of colors in the figure to clearly show the difference. Mainly the groundwater scarcity is classified into four groups: low (GWS < 1.0), moderate (1.0 < GWS < 1.5), significant (1.5 < GWS < 2.0) and severe (GWS > 2.0), when GWS>=1.0, the province becomes a hotspot.)

For 10-year averaged annual BWS, the averaged, maximum and minimum values are evaluated by 24 combining EFR methods. Figure 8 shows that the extent of BWS is not as severe as the scarcity only considering SWS or GWS, which may because of the large uncertainty of EFR methods. The eastern to the southern parts of Iran, which are located within the arid and hyper-arid climatic regions, did not have BWS in 1981-2000 except for SouthKhorasan and RazaviKhorasan. The rest of the provinces in the arid zone such as NorthKhorasan, Semnan and Tehran, which are located in the northern or western part of Iran, faced different levels of BWS before the year 2000. The BWS of most of the provinces did not exceed 2.0, which means that most of the provinces were not suffering from severe BWS before the year 2000. However, the semi-arid, arid and hyper-arid zone need to be paid more attention to since the BWS in this region was increasing over time. As for humid zone and dry-sub humid zone, three provinces in these regions not faced BWS until the year 2000, while Gorgan province (dry-sub humid zone) suffered from significant to severe BWS from the year 2001. In a word, the BWS level was getting higher over the study period, and it showed rapid growth in the 2001-2010 decade, which may because of the rapid blue water demand growth in Iran since the 1980s .

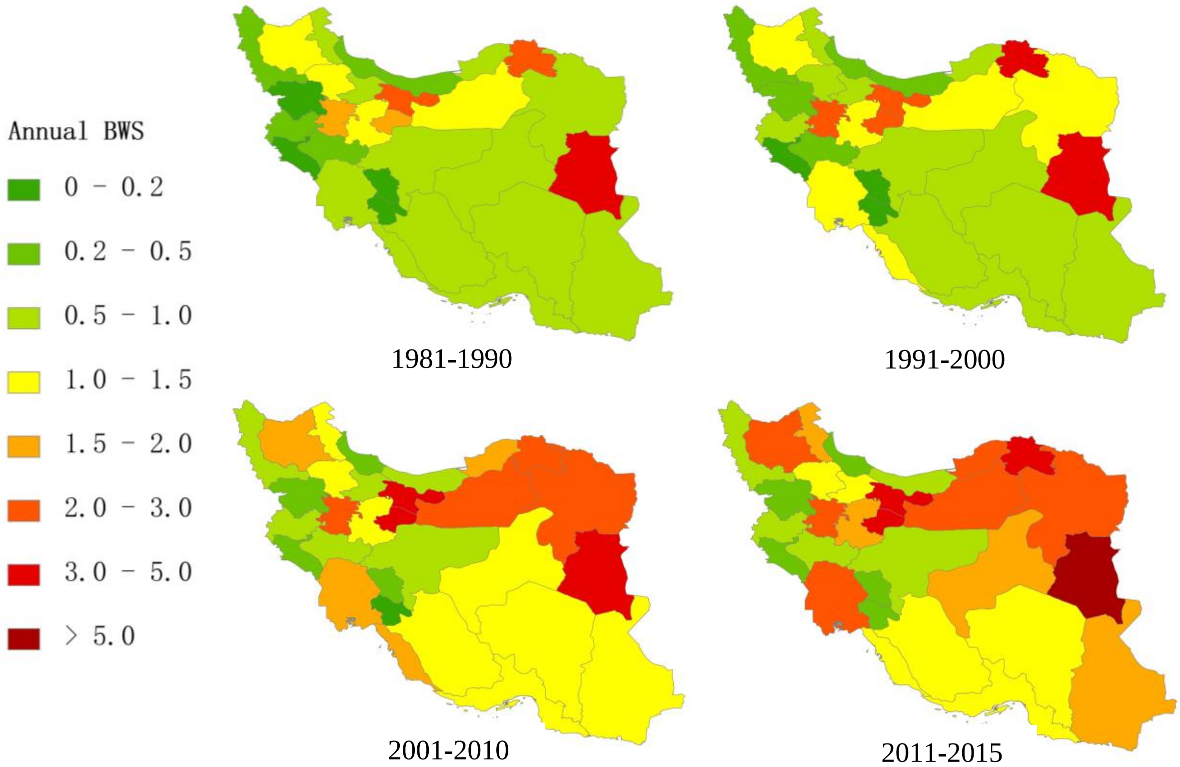
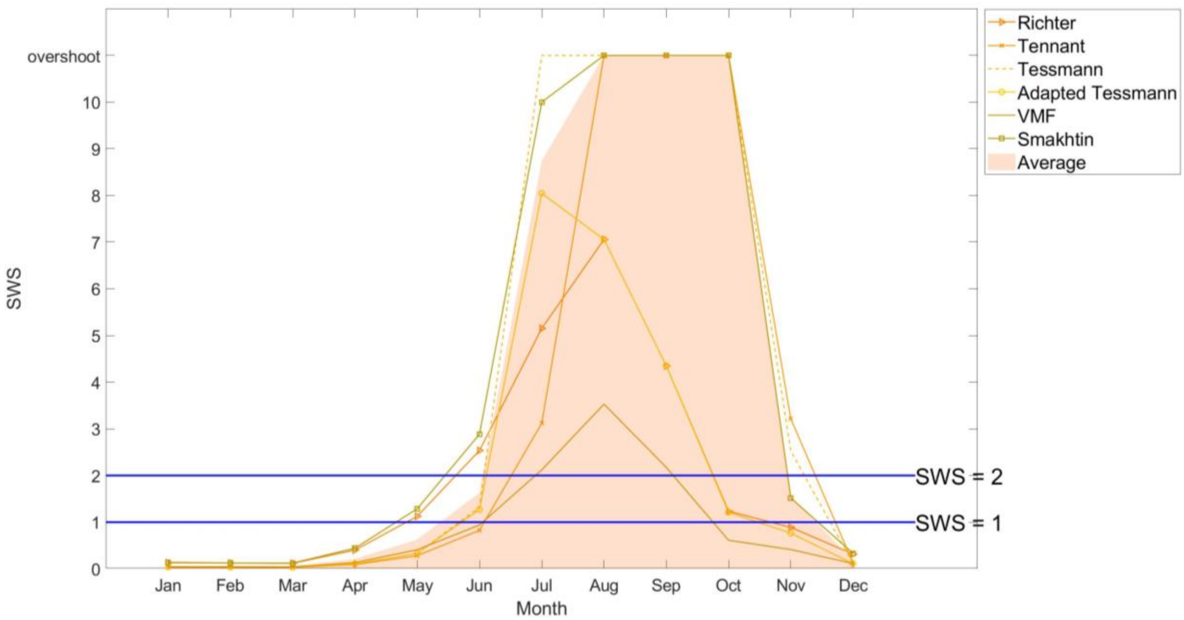


Figure 8. 10-year averaged annual total blue water scarcity in the period of 1981 to 2015 (annual BWS value is an average value of the results calculated by the combination of six EFR_{SW} methods and four EFR_{GW} methods. Annual BWS is categorized into 8 kinds of colors in the figure to clearly show the difference. Mainly the total blue water scarcity is classified into four groups: low (BWS < 1.0), moderate (1.0 < BWS < 1.5), significant (1.5 < BWS < 2.0) and severe (BWS > 2.0), when BWS>=1.0, the province becomes a hotspot.)

- **Temporal Variation**

The temporal variation of monthly SWS, annual GWS and annual BWS of the whole country over the study period has been presented in Figure 9. According to the figure of monthly SWS in Iran, the values assessed by different EFR_{SW} methods exceeded 1.0 from July to October. Overshoots are presented in August, September and October, which may result from a small amount of BWA in these months. Smakhtin method provides the most conservative value in most of the months during one year. In the study period, taking the average annual GWS as the example, the GWS always exceeds 1.0 and it was increasing over the year. The annual BWS showed a similar pattern with the annual GWS, it was gradually getting severe by year. Since the year 2007, the annual BWS exceeded or exactly equal to 1.0 according to the averaged value. For the maximum results by 24 combined EFR methods, the scarcity was mostly between 1.0 and 2.0 (although its value exceeded 2.0 since 2006), which was therefore moderate to significant scarcity; for the minimum results, it showed low BWS during 1981-2015. Hence, the BWS results provide a large uncertainty with a value range of 0.5-2.5. It makes a consequence that it is hard to say whether the BWS is severe at the national scale over the study period.


Richter
Tennant
Tessmann
Adapted Tessmann
VMF
Smakhtin
Average
overshoot
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SWS = 2
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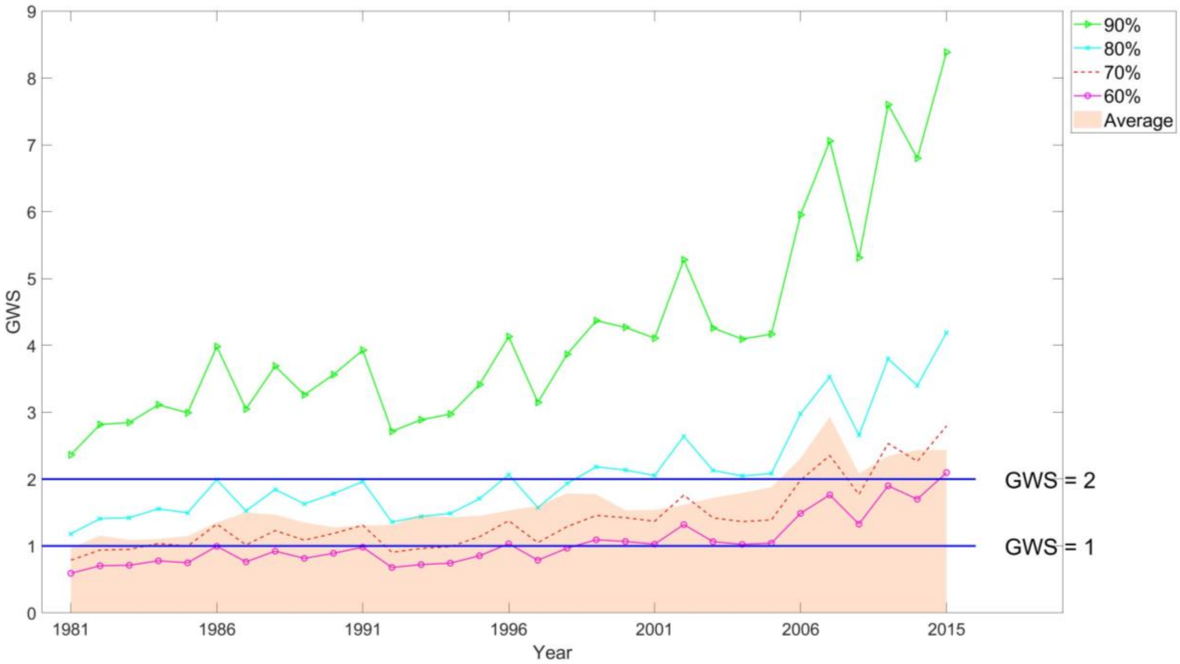
90%
80%
70%
60%
Average
GWS
GWS = 2
GWS = 1
Year
1981
1986
1991
1996
2001
2006
2015

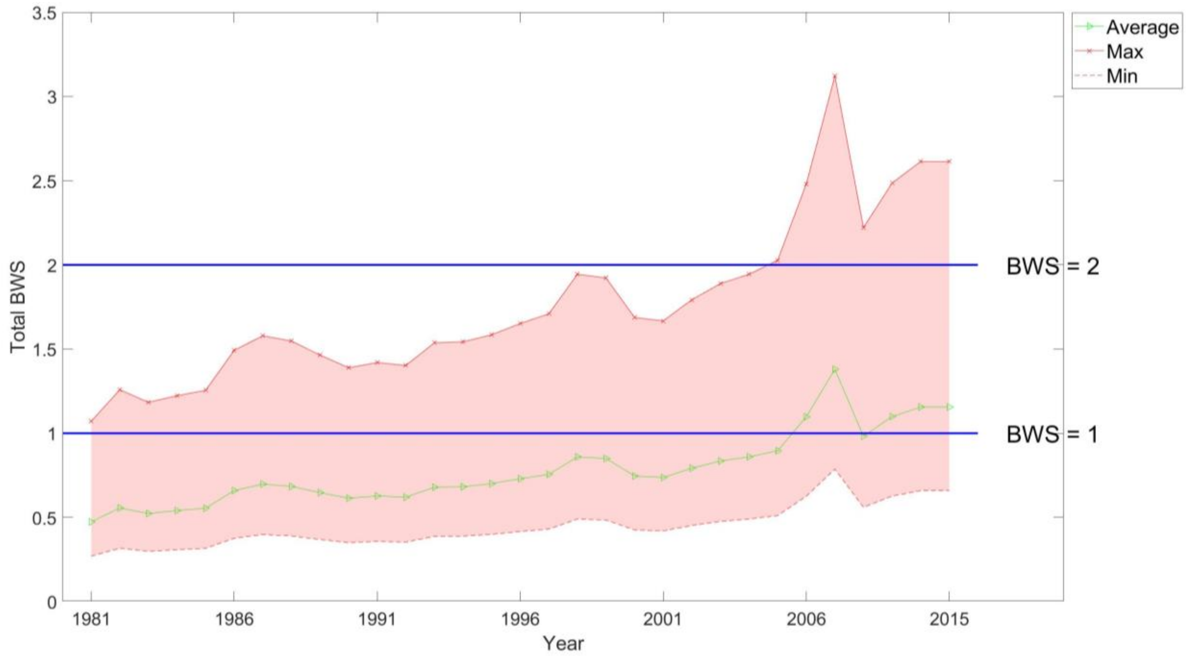

Figure 9. Temporal variation of monthly surface water scarcity/annual groundwater scarcity/annual total blue water scarcity of Iran in the period of 1981 to 2015 (Sub-figure1: monthly SWS calculated by six EFR_{SW} methods and their average value are presented, SWS value ranges from 0-overshoot, when SWS>10, it is regarded as an "overshoot" value; Sub-figure2: annual GWS calculated by four EFR_{GW} methods and their average value are presented; Sub-figure3: annual BWS is calculated by the combination of six EFR_{SW} methods and four EFR_{GW} methods, and the max, min and ave value of 24 resulted values are presented over the study period.

4.1.2 Violation of Blue WF in EFRs

The first sub-graph of Figure 10 presents the comparison of BWR_{SW}, BWF_{SW} and BWA_{SW} at monthly scale. Then the rest two sub-graphs are the total violation rate of EFRs by BWF_{SW} and the contribution of different sectors in EFR_{SW} violation. It is clear that BWF_{SW} nearly equals BWR_{SW} from July to September while the BWA_{SW} in these months were approximately equal to zero. Meanwhile, the violation from July to September was nearly 100%, which means EFRs were fully violated in these months. According to the final sub-graph in Figure 10, the agriculture sector contributed the most in total violation in June-September, no surface water resources is available in these months; while from October to November, domestic and industrial sector consumed more surface water resources than agriculture sector possibly due to fallow period.

Figure 11 shows the temporal variation of groundwater resources' condition by year. The groundwater discharge showed a fluctuation over the study period. Meanwhile, a rapid ascending trend was shown in BWF_{GW} since 2004. Taking 60% groundwater recharge as EFR_{GW} (EFR_{GW}-60%) can mostly meet the required environmental uses in the first 25 years, however, it can no longer meet the requirement from the year 2006 during the study period. Taking 90% groundwater recharge as EFR_{GW} (EFR_{GW}-90%) seems quite strict, BWF_{GW} was higher than BWA_{GW} all the time during the study period. The rate of EFR_{GW} violation by BWF_{GW} showed such a growth in a fluctuation, and in most of the recent ten years, the EFR_{GW}s were fully violated by BWF_{GW}. The groundwater resources consumed by the domestic and industrial sectors were much lower than they consumed by the agricultural sector, the violation which contributed by agriculture nearly equaled to the average total violation.

Figure 12 indicates the total violated rate of EFRs caused by total BWF. EFRs are estimated by 24 combined methods, but only the maximum, minimum and average values are presented. The difference of methods was large, the minimum result showed no violation in the whole period. But for the maximum result, it had a fluctuation in the period, and in 2009 and 2015, the violation became about 100%. Agriculture contributed nearly 100% of the total violation. The total violation was increasing over the year may because of the increasingly blue water consumption by agriculture. It reflected the importance of taking action on limiting agricultural blue water use.

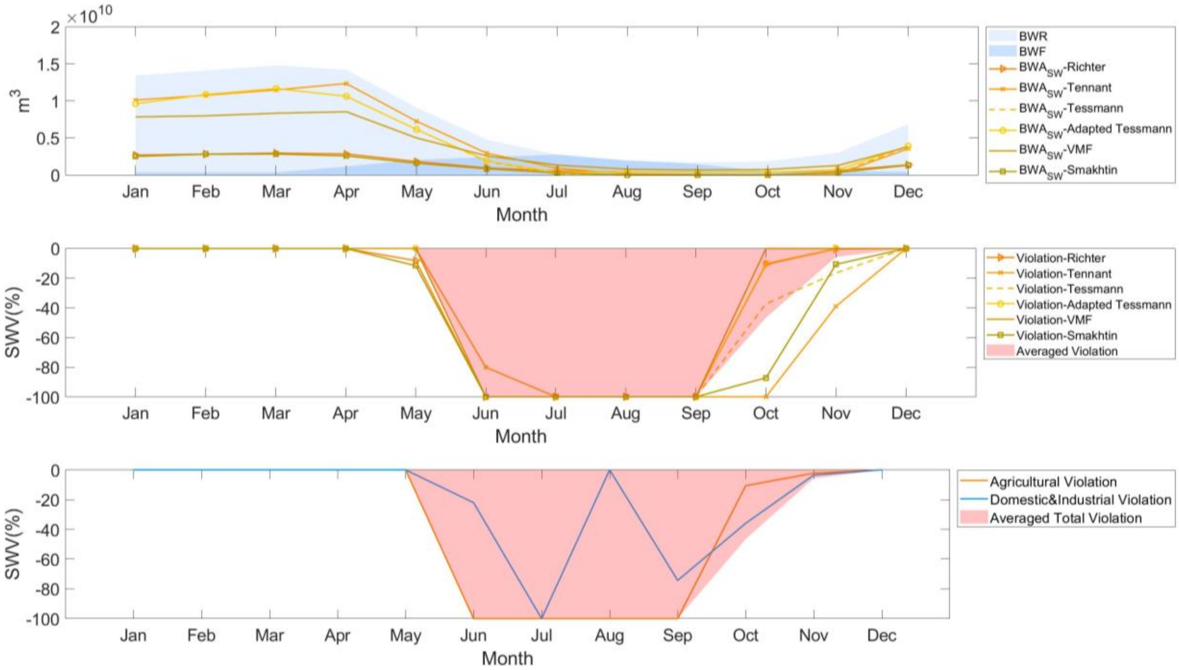

Figure 10. Temporal variation of monthly BWR_{SW} versus BWF_{SW} versus BWA_{SW} and the violation of BWF_{SW} in EFRs of Iran using six EFR_{SW} methods in 1981-2015 (Sub-figure 1: A comparison among monthly BWR_{SW},BWF_{SW} and BWA_{SW} calculated by six EFR_{SW} methods, the area shown in light blue color refers to BWR_{SW}, the area shown in dark blue color refers to BWF_{SW} and six lines are the corresponding BWA_{SW} estimated by six EFR_{SW} methods; Sub-figure 2: Monthly EFR_{SW} violations by six EFR_{SW} methods, the red area shows the average value of each EFR_{SW} violations; Sub-figure 3: Monthly EFR_{SW} violations and the contribution of the different sector in the EFR_{SW} violations, the red area also shows the average value of each EFR_{SW} violations.）

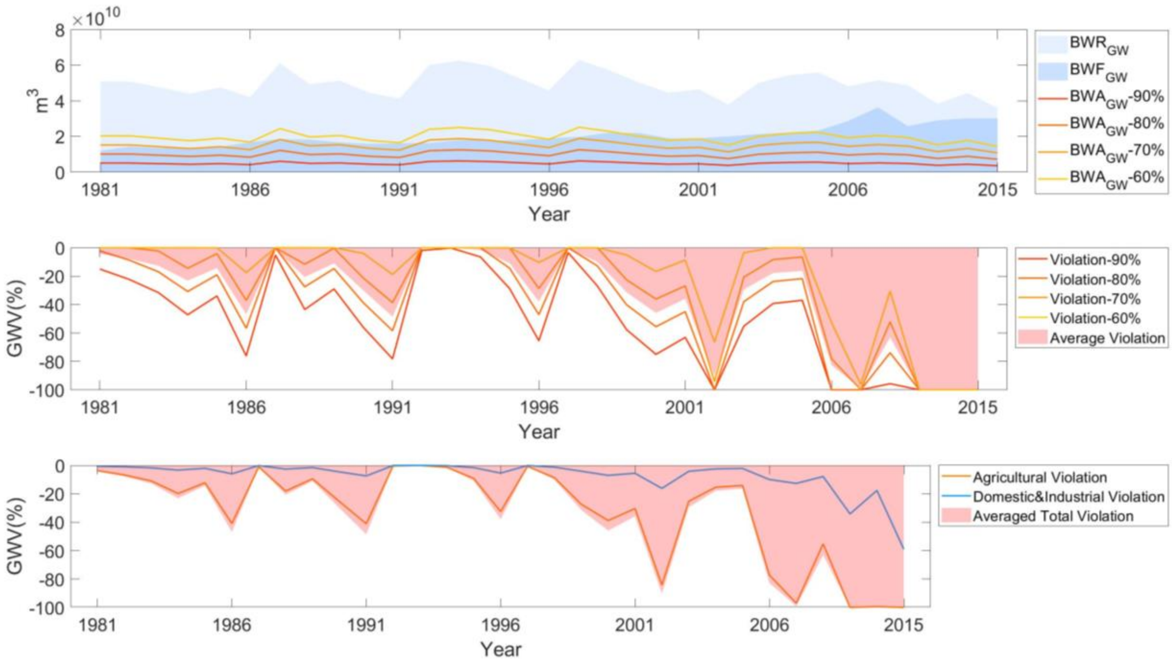

Figure 11. Temporal variation of annual BWR_{GW} versus BWF_{GW} versus BWA_{GW} and the violation of BWF_{GW} in EFRs of Iran using four EFR_{GW} methods in 1981-2015 (Sub-figure 1: A comparison among annual BWR_{GW},BWF_{GW} and BWA_{GW} calculated by four EFR_{GW} methods, the area shown in light blue color refers to BWR_{GW}, the area shown in dark blue color refers to BWF_{GW} and six lines are the corresponding BWA_{GW} estimated by four EFR_{GW} methods; Sub-figure 2: Annual EFR_{GW} violations by four EFR_{GW} methods, the red area shows the average value of each EFR_{GW} violations; Sub-figure 3: Annual EFR_{GW} violations and the contribution of different sector in the EFR_{GW} violations, the red area also shows the average value of each EFR_{GW} violations.）

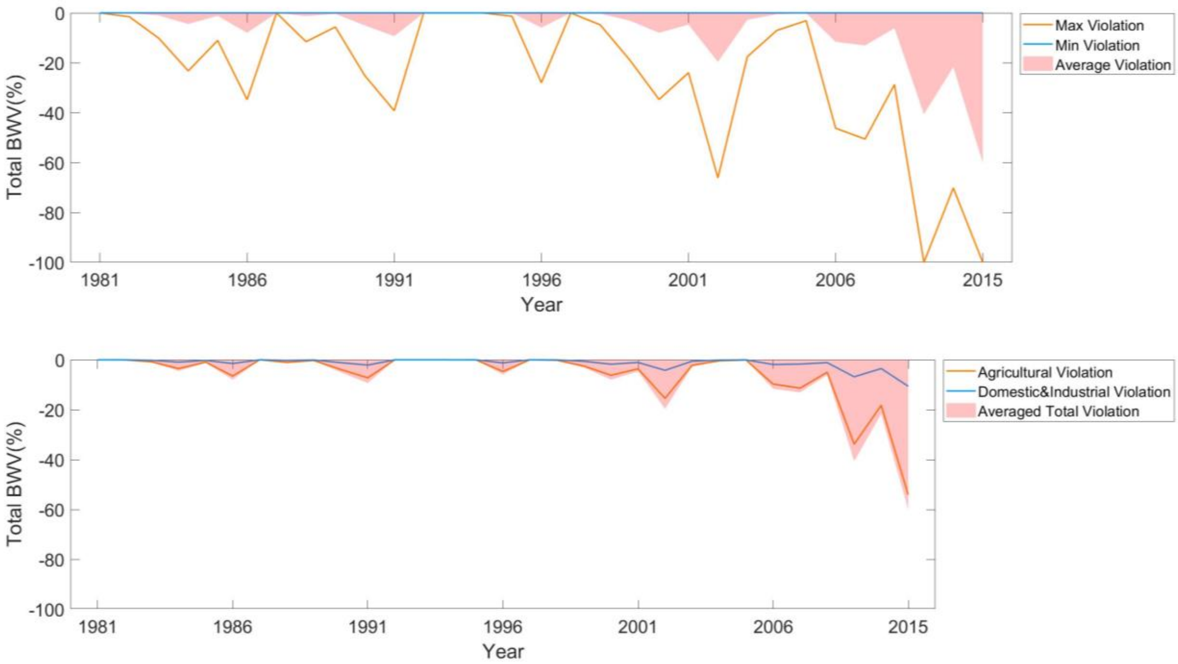

Figure 12. Temporal variation of the violation of BWF in EFRs of Iran using six EFR_{SW} methods and four EFR_{GW} methods in 1981-2015 and the contribution of agriculture, domestic and industry in BWF violation of Iran during the period of 1981-2015 (Sub-figure 1: Max,min and ave value of annual EFR violations by the combination of six EFR_{SW} methods and four EFR_{GW} methods,

the red area shows the average value of each EFR violations; Sub-figure 2: Annual EFR violations and the contribution of different sector in the EFR violations, the red area also shows the average value of each EFR violations.)

4.3 Blue WF Cap Options and Violations

This section mainly presents the results of the scenarios formulated previously. First, the actual supply and UFD are compared with each other under a certain DFL. Then the EFR_{SW} and EFR_{GW} violations of each province under each scenario are shown in the Iran map. The formulated scenarios can be referred to in Table 5. Other important information will also be presented in this section.

4.3.1 UFD VS. Actual Supply VS. BWR

Figure 13 presents the percentage of UFD of each province per month/year under Scenario A-D in the period of 1981-2015. It shows that all provinces are 0%-5% under-fulfilled under Scenario A and B, only some of the northern provinces are 5%-10% under-fulfilled under Scenario C, while most of the provinces are at least 5% under-fulfilled under Scenario D. Figure 14 visualizes actual supply and UFD per month/year under Scenario C during 1981-2015. The results of Scenario A, B and D are listed in Appendix B. Figure 14 shows that the 75% DFL can satisfy most of the months from 1981 to 2005 at the national scale, only a small amount of demand from January to March cannot be satisfied, although BWAs in these months are relatively larger than in other months. It is obvious that the total demand of the whole country was rising by the year, and there was a jump of demand in the year 2007, later the demand decreased to the original level. Linking to Figure 15, only the demands in dry months (April-September) during the year were under-fulfilled, most of the demands in wet months were satisfied, especially in wet years except the year 2007. The year 2007 was a wet year and the BWR of Iran in this year was up to $1.73*10^{12}$ m^3. However, there was a large total blue water requirement this year, which remained the demand under-fulfilled nearly the whole year.

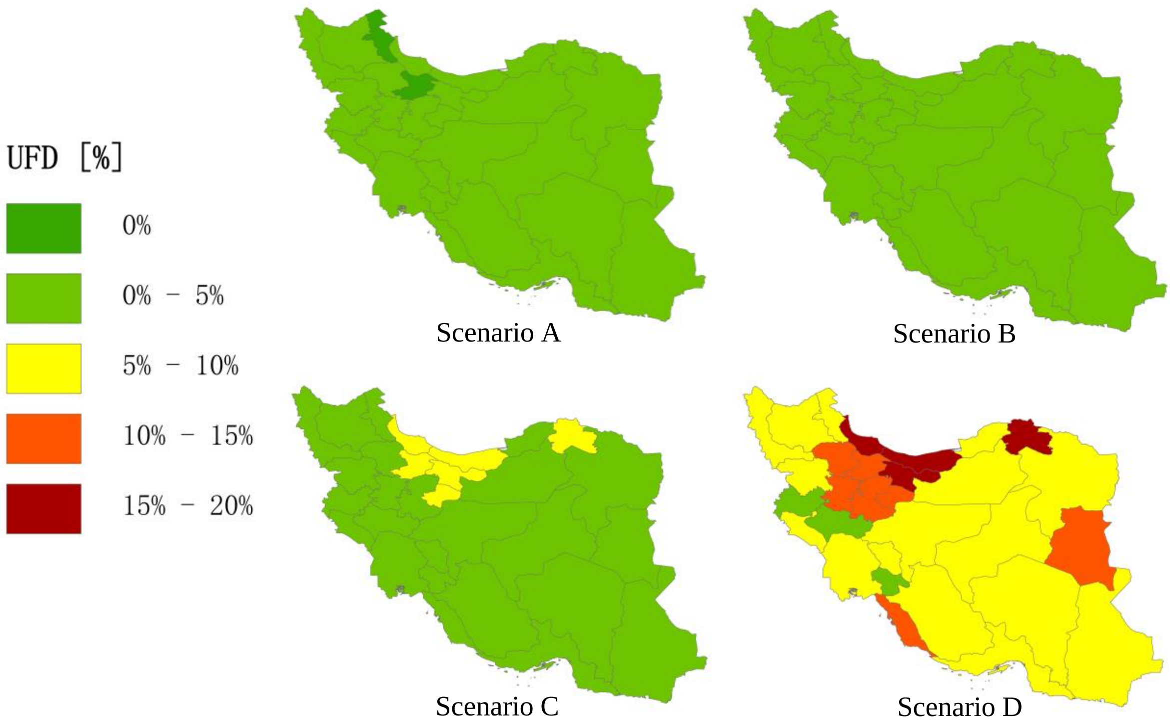

Figure 13. Spatial distribution of UFD percentage per month/year in Iran under Scenario A-D in the period of 1981-2015

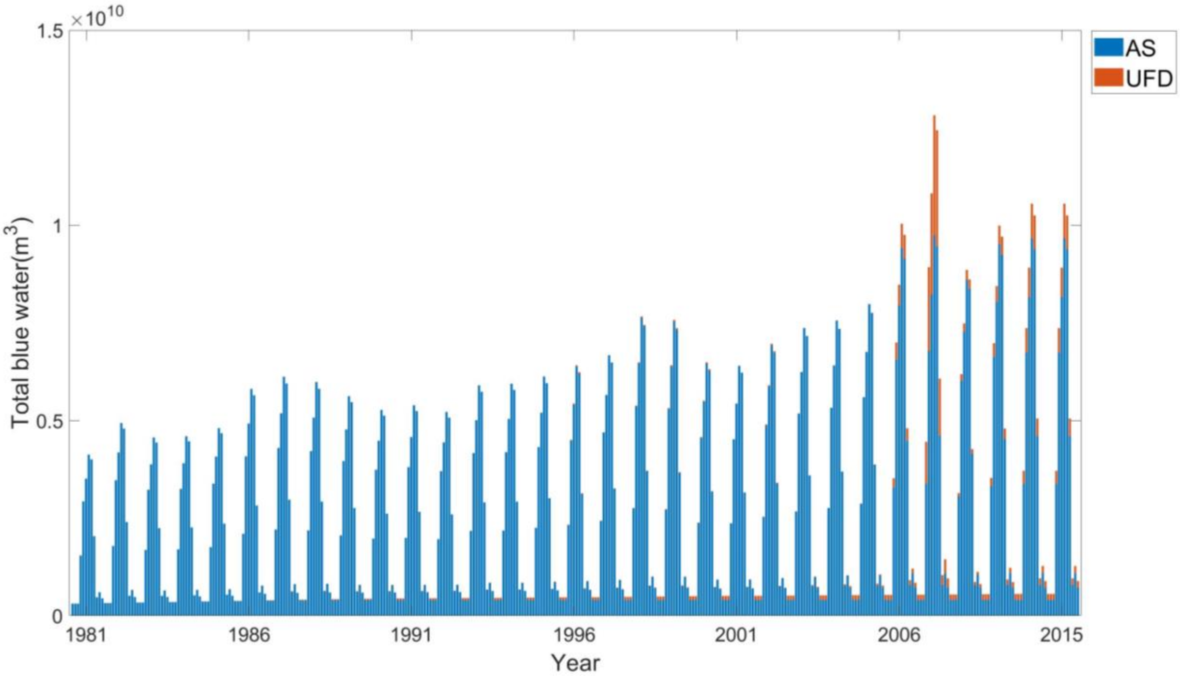

Figure 14. Actual supply VS. UFD in Iran under Scenario C during 1981-2015(the red stack refers to the actual supply for each year and month under Scenario C, the blue stack refers to under fulfilment of demand for each year and month under Scenario C)

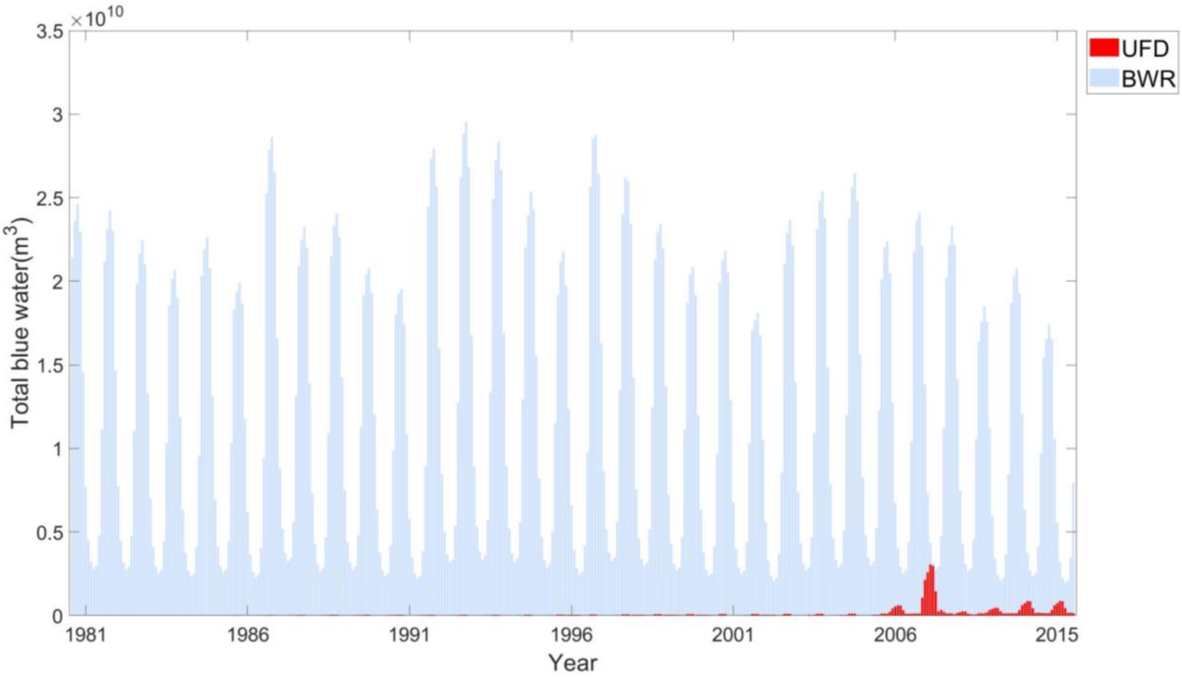

Figure 15. BWR VS. UFD in Iran under Scenario C during 1981-2015 (the light blue stack refers to BWR for each year and month under Scenario C, the red stack refers to under fulfilment of demand for each year and month under Scenario C)

4.3.2 Spatial Distribution of Annual EFR_{SW} and EFR_{GW} Violation

Figure 16 presents the sum percentage of annual EFR_{SW} and EFR_{GW} violations under each scenario. Reducing BWC shows a slight relief on the annual value of EFR_{SW} and EFR_{GW} violation, while changing SWC can make a large difference in influencing the EFR violations.

With total BWF cap-reduction (from 100%DFL to 60%DFL), only one or two provinces (eg. Semnan, Tehran, Qom and Qazvin) present a slight relief on the sum of annual EFR_{SW} and EFR_{GW} violation. And the total EFR violation of each province is exactly within the same range under Scenario A and Scenario B.

With three different SWC options, the sum of EFR violation difference is large under Scenario X1, X2 and X3 (X refers to A, B, C or D) even in the same DFL. With Scenario X1 and X2, the EFR violation more or less occurs in each province. Nevertheless, most provinces in Iran suffer at least 50% violation under Scenario X1, while suffering not exceeding 50% violation under Scenario X2. Such high EFR violation occurs may because the maximum BWA_{SW} is considered as SWC under Scenario X1. Under Scenario X3, most provinces have 50% - 100% violation, the west and north part of Iran have no violation according to the figure.

Specifically, provinces which are located in the northeast of the country (NorthKhorasan, Semnan, RazaviKhorasan and SouthKhorasan) suffer relatively higher violation under each scenario, also with Hamedan province included. Scenario X1 results in up to 200% of total EFR violations in these provinces. The provinces in northeastern Iran mainly are arid areas except Hamedan, Hamedan shows a high violation under each scenario, ranging from 50% to 200%. Northwestern Iran is mostly semi-arid except EastAzarbaijan. Semi-arid areas do not have such high violations, always lower than 100% except Hamedan. Some provinces in this climate zone even have no violation under Scenario X3, such as WestAzarbaijan, Kordestan, Ilam and so on. The dry-sub humid area and the humid area suffer different but relatively low levels of violation under Scenario X1 or X2. Gorgan as a dry-sub humid area has up to 100% violation under each scenario, and it is violated 50%-100% under Scenario X3, while under Scenario X1 or X2, it is violated lower than 50%.

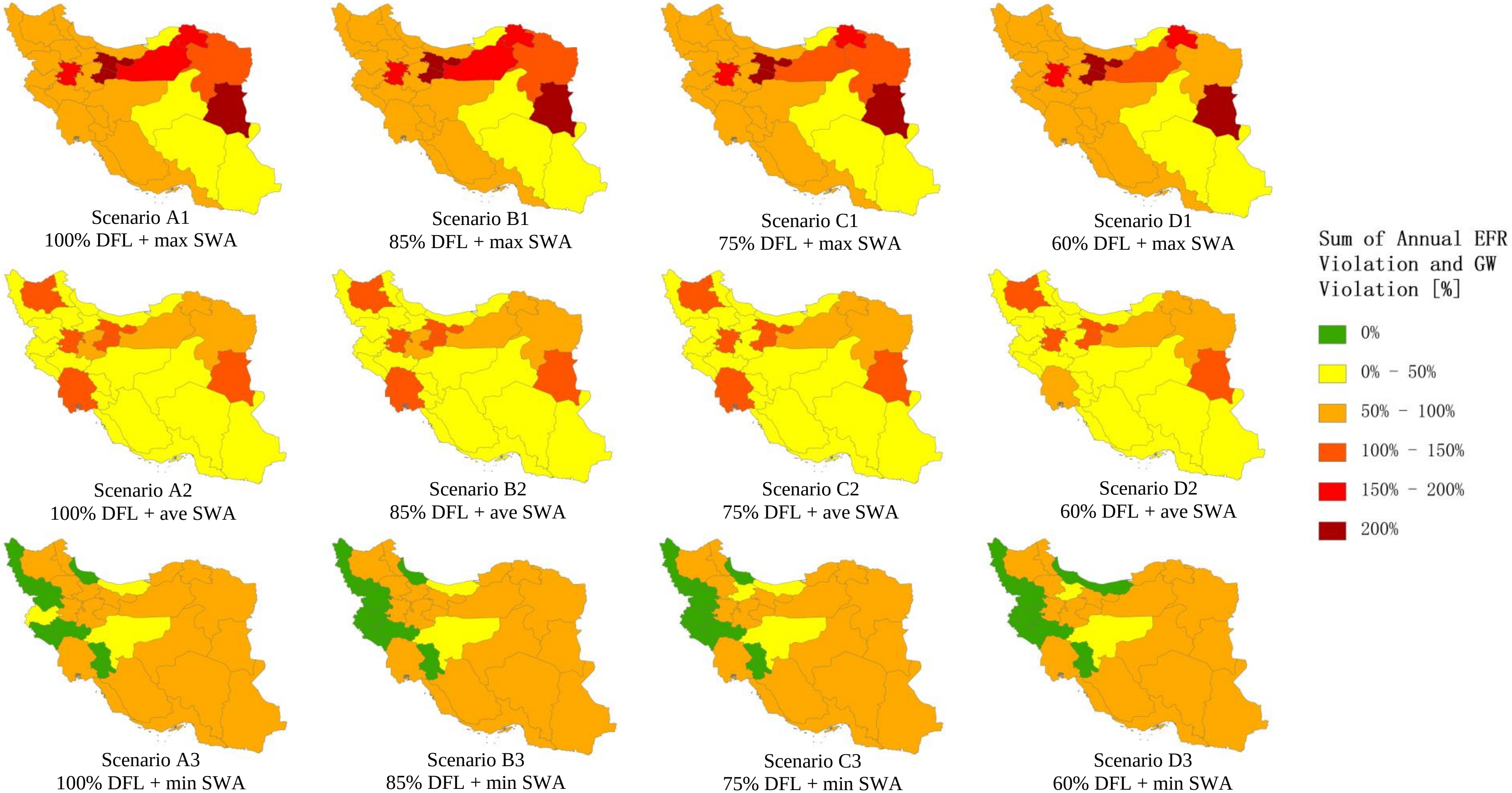

Figure 16. Spatial distribution of the summation of annual EFR_{SW} and EFR_{GW} violation under 12 scenarios (Six levels of the sum of surface water and groundwater violation are presented. The annual violation is the average value of annual EFR violations calculated by six EFR_{SW} methods and four EFR_{GW} methods individually. From left hand to right hand, total BWC has been cut down with the same SWC; while from up to down, SWC has been cut down with the same total BWC. The green area means that there is no EFR violation, and conversely, the darkest red area means that the EFR_{SW} and EFR_{GW} violations in this area are both 100%.)

4.3.3 Analysis of EFR_{SW} and EFR_{GW} Violations in Climate Zone

Table 6 quantifies the EFR_{SW} violations under each monthly SWC for each climate zone. The table shows a wide range of uncertainty when analyzing the EFR_{SW} violations. Moreover, the EFR_{SW} violations largely reduce under different SWC levels.

The annual violated volume of each climate zone not only depends on the violated degree of each province in the certain climate zone but also the size of climate zones (e.g. the number of provinces, the area of provinces). Among five climate zones, the arid zone is largely violated, ranking the first of annual violated volume, no matter which SWC option is taken. Under Scenario X1, the arid zone suffers nearly or exactly 100% violation the whole year. However, with the reduction of SWC, fewer surface water resources can be used under Scenario X2 and X3, the EFR_{SW} violation in this climate zone declines significantly.

Almost no violation occurs under Scenario X3, only about two months' EFRs are violated in each climate zone. Setting minimum BWA_{SW} as SWC is such a strict cap option for surface water resources, it is somewhat unrealistic to set caps so low when the study area already suffers severe water scarcity, while it has been included to study the potential reduction of EFR_{SW} violations and the potential influence for EFR_{GW} violations.

Table 7 shows to what extent that the groundwater resources are violated under each scenario for each climate zone during 1981-2015. The table clearly shows that 75% DFL can satisfy most of the demand (with 92%-98% of actual demand in the study period) of each climate zone. EFR_{GW} violation is decreasing by the total BWC being cut down and the reduction is the largest under Scenario X3. It decreases by 3%-22% when the total BWC being cut by 40%. According to the comparison of violation rate under different SWC with the same BWC, the EFR_{GW} violation increases along with the monthly SWC decreasing. And a large difference in EFR_{GW} violations has been presented under Scenario X2 and X3, especially in the hyper-arid and arid zone (maximumly having a difference of 83% EFR_{GW} violation). It is obvious that no EFR_{GW} is violated under Scenario X1 because of the loose SWC. Moreover, it is worth mentioning that the groundwater resources in the hyper-arid zone, semi-arid zone and humid zone are not violated under Scenario X1 and X2.

Table 6. EFR_{SW} violations for five climate zones in Iran under three SWC options

Climate zone	**SWC**	**EFR_{SW} violation[1]**				
		Annual violated volume (range by EFR_{SW} methods) [million m^3 y^{-1}]	Annual violated volume (average by EFR_{SW} methods) [million m^3 y^{-1}]	Monthly violation (average by EFR_{SW} methods) [%]	# mo y^{-1} (average by EFR_{SW} methods)	# 90 mo (average by EFR_{SW} methods)
Hyper arid	max BWA_{SW} (Scenario X1)	1000.66-7533.08	3880.02	0%-100%	10.3	5.5
	ave BWA_{SW} (Scenario X2)	0.00-3692.42	1214.39	38%-100%	7.2	1

	min BWA_{SW} (Scenario X3)	0.00-0.00	0.00	0%-0%	2.7	0
Arid	max BWA_{SW} (Scenario X1)	2030.43-14159.31	7012.58	100%-100%	10.8	5.2
	ave BWA_{SW} (Scenario X2)	0.00-7320.05	2263.21	44%-100%	7.3	0.8
	min BWA_{SW} (Scenario X3)	0.00-0.00	0.00	0%-3%	2.0	0
Semi arid	max BWA_{SW} (Scenario X1)	1345.70-8670.84	4377.39	0%-100%	11.5	5.5
	ave BWA_{SW} (Scenario X2)	0.00-4443.82	1378.85	64%-100%	7.2	0.3
	min BWA_{SW} (Scenario X3)	0.00-0.00	0.00	0%-37%	1.9	0
Dry sub-humid	max BWA_{SW} (Scenario X1)	994.07-7229.98	3608.65	0%-100%	11.1	4.7
	ave BWA_{SW} (Scenario X2)	0.00-3683.08	1141.84	68%-100%	6.3	0.6
	min BWA_{SW} (Scenario X3)	0.00-0.00	0.00	0%-24%	1.5	0
Humid	max BWA_{SW} (Scenario X1)	1733.72-13084.79	6330.16	0%-100%	11.9	4.8
	ave BWA_{SW} (Scenario X2)	0.00-6874.01	2055.98	33%-93%	7	0
	min BWA_{SW} (Scenario X3)	0.00-0.00	0.00	0%-0%	1.6	0

[1] EFR_{SW} violated volume is expressed in million cubic meter per year, monthly violation is expressed in percentage, #mo y^{-1} refers to the average number (#) of months per year EFR is violated, and #90mo refers to the average number of months 90% or more of EFR is violated.

Table 7. Annual UFD and EFR_{GW} violations for five climate zones under each scenario

Climate zone	**Scenario Names**	**WF cap option**		**UFD [%]**	**EFR_{GW} violation[2]**		
		DFL [%]	SWC		Annual violated volume (range by EFR_{GW} methods) [million m^3 y^{-1}]	Annual violated volume (average by EFR_{GW} methods) [million m^3 y^{-1}]	Annual violation (average by EFR_{GW} methods) [%]
Hyper arid	A1	100%DFL	max BWA_{SW}	0%	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}		0.00-96.83	24.21	0%
	A3		min BWA_{SW}		357.58-2266.87	1312.22	38%
	B1	85%DFL	max BWA_{SW}	1%	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}		0.00-47.00	11.75	0%
	B3		min BWA_{SW}		307.75-2217.04	1262.39	36%
	C1	75% DFL	max BWA_{SW}	3%	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}		0.00-0.00	0.00	0%
	C3		min BWA_{SW}		177.01-2086.30	1131.66	31%
	D1	60% DFL	max BWA_{SW}	7%	0.00-0.00	0.00	0%

	D2		ave BWA_{SW}		0.00-0.00	0.00	0%
	D3		min BWA_{SW}		0.00-1836.32	899.92	23%
Arid	A1	100%DFL	max BWA_{SW}	0%	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}		0.00-3436.24	1165.14	7%
	A3		min BWA_{SW}		5304.50-11940.30	8622.40	90%
	B1	85%DFL	max BWA_{SW}	1%	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}		0.00-3226.10	1060.07	6%
	B3		min BWA_{SW}		5094.36-11730.16	8412.26	88%
	C1	75% DFL	max BWA_{SW}	2%	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}		0.00-2774.02	834.03	5%
	C3		min BWA_{SW}		4642.28-11278.08	7960.18	83%
	D1	60% DFL	max BWA_{SW}	7%	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}		0.00-1561.91	390.48	2%
	D3		min BWA_{SW}		3430.17-10065.97	6748.07	68%
Semi arid	A1	100%DFL	max BWA_{SW}	0%	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}		0.00-0.00	0.00	0%
	A3		min BWA_{SW}		0.00-1285.80	321.45	2%
	B1	85%DFL	max BWA_{SW}	1%	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}		0.00-0.00	0.00	0%
	B3		min BWA_{SW}		0.00-1167.02	291.76	2%
	C1	75% DFL	max BWA_{SW}	2%	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}		0.00-0.00	0.00	0%
	C3		min BWA_{SW}		0.00-1067.03	266.76	2%
	D1	60% DFL	max BWA_{SW}	5%	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}		0.00-0.00	0.00	0%
	D3		min BWA_{SW}		0.00-656.13	164.03	1%
Dry sub-humid	A1	100%DFL	max BWA_{SW}	0%	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}		0.00-141.19	47.44	7%
	A3		min BWA_{SW}		71.94-349.86	210.90	44%
	B1	85%DFL	max BWA_{SW}	1%	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}		0.00-122.69	38.18	5%
	B3		min BWA_{SW}		53.43-331.36	192.39	38%
	C1	75% DFL	max BWA_{SW}	3%	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}		0.00-101.64	27.66	4%
	C3		min BWA_{SW}		32.38-310.31	171.35	33%
	D1	60% DFL	max BWA_{SW}	7%	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}		0.00-60.47	15.12	2%
	D3		min BWA_{SW}		0.00-269.14	132.37	23%
Humid	A1	100%DFL	max BWA_{SW}	0%	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}		0.00-0.00	0.00	0%
	A3		min BWA_{SW}		0.00-217.08	54.27	3%
	B1	85%DFL	max BWA_{SW}	3%	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}		0.00-0.00	0.00	0%
	B3		min BWA_{SW}		0.00-164.64	41.16	2%
	C1	75% DFL	max BWA_{SW}	8%	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}		0.00-0.00	0.00	0%
	C3		min BWA_{SW}		0.00-81.99	20.50	1%
	D1	60% DFL	max BWA_{SW}	18%	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}		0.00-0.00	0.00	0%

	D3		min BWA_{SW}		0.00-0.00	0.0	0%

[2]EFR_{GW} violated volume is expressed in million cubic meter per year and annual EFR_{GW} violation is expressed in percentage.

4.3.4 Sustainable Cap Options and Implications of Caps for Provinces in Iran

Table 8 presents the possible caps according to 12 scenarios for each province and also compares some implications for the environment before setting caps with them after setting caps. These appropriate provincial caps are considered relatively sustainable caps for each province in Iran within the study period. They are selected by meeting four conditions: [1]UFD ≤ 5%; [2]The number of months in which EFRs are violated ≤ 6 or the number of months in which 90% EFRs are violated ≤ 3; [3]The annual GWV ≤ 60% (if there are more than one resultant scenario, then the scenario with lowest GWV can be chosen; [4]If more than one scenario remained, Scenario C is preferred (because the demand fulfilment of Scenario C is considered as the most appropriate at national scale for each year and month during the study period according to the previous analysis). Despite these four conditions, some occasional caps can be regarded as "sustainable" for provinces that are already facing severe BWS, for instance, EastAzabaijan, Qom, Khuzestan, NorthKhorasan, SouthKhorasan and Tehran.

The individual surface water and groundwater resources contributions in both BWF and BWC are also presented in Table 8. The compositions of surface water and groundwater resources in the total blue water supply have been redistributed after setting caps. To maximally reduce the SWV, the larger percentage of groundwater resources are allocated in the capping stage for most of the provinces, especially for provinces where BWA_{GW} is larger than BWA_{SW} such as Qom, Markazi and RazaviKhorasan. Although the composition of GWC in BWC is large, the resultant GWV can be low because of the total BWC reduction.

For provinces that are already facing severe BWS, occasional "sustainable" caps are set, and all of them are set under Scenario D2. Although some provinces should limit their demand by approximately 15%-20%, such strict or even stricter caps should be set to protect the environment. For provinces where the violation values vary in a large range using different SWCs such as Sistan and Zanjan (the implications under each scenario are presented in Appendix B3), a better suggestion is to set a more specific SWC between ave BWA_{SW} and min BWA_{SW}. For some BWA_{SW} – rich provinces such as Gilan and Mazandaran (both in the humid zone), relatively looser caps are set (Scenario B3).

Table 8. Appropriate province-specific caps and the comparisons on implications between current situation and situation under such caps

Province	Scenario Names	WF cap option		UFD [%]	Current SW Contribution in BWF [%]	SW Contribution in BWC (SWC) [%]	Current GW Contribution in BWF [%]	GW Contribution in BWC (GWC) [%]	Current #mo	Under chosen cap #mo	Current #90mo	Under chosen cap #90mo	Current Annual GWV [%]	Under chosen cap Annual GWV [%]
		DFL [%]	SWC											
Ardebil	C2	75%DFL	ave BWA_{SW}	3%	78%	59%	22%	41%	5.0	6.6	4.1	0.4	41%	0%
WestAzarbaijan	C3	75%DFL	min BWA_{SW}	2%	60%	47%	40%	53%	3.2	1.0	1.2	0.0	30%	0%
EastAzarbaijan	D2	60%DFL	ave BWA_{SW}	7%	60%	48%	40%	52%	5.5	6.7	4.0	0.8	95%	57%
Bushehr	C2	75%DFL	ave BWA_{SW}	3%	58%	41%	42%	59%	7.2	8.7	6.5	1.4	57%	5%
Chaharmahal	C3	75%DFL	min BWA_{SW}	2%	46%	66%	54%	34%	3.9	2.4	0.0	0.0	2%	0%
Esfahan	C3	75%DFL	min BWA_{SW}	2%	27%	35%	73%	65%	3.7	1.3	0.5	0.0	41%	6%
Fars	C2	75%DFL	ave BWA_{SW}	3%	27%	37%	73%	63%	7.0	8.4	6.2	1.2	28%	1%
Qazvin	B3	85%DFL	min BWA_{SW}	2%	40%	21%	60%	79%	4.6	1.0	2.7	0.0	15%	10%
Qom	D2	60%DFL	ave BWA_{SW}	14%	26%	19%	74%	81%	8.0	6.6	6.0	1.0	74%	84%
Gilan	B3	85%DFL	min BWA_{SW}	4%	81%	51%	19%	49%	4.2	0.8	2.0	0.0	1%	0%
Gorgan	C2	75%DFL	ave BWA_{SW}	3%	56%	28%	44%	72%	5.4	6.3	4.4	0.6	25%	4%
Hamedan	C2	75%DFL	ave BWA_{SW}	4%	22%	13%	78%	87%	7.7	6.6	5.6	0.2	51%	52%
Hormozgan	C2	75%DFL	ave BWA_{SW}	2%	23%	46%	77%	54%	6.9	8.3	4.7	1.0	66%	0%
Ilam	C3	75%DFL	min BWA_{SW}	4%	56%	58%	44%	42%	3.6	2.2	0.4	0.0	2%	0%
Kerman	C2	75%DFL	ave BWA_{SW}	2%	20%	35%	80%	65%	6.2	7.4	3.2	0.7	45%	1%
Kermanshah	D3	60%DFL	min BWA_{SW}	4%	50%	29%	50%	71%	3.6	0.5	1.8	0.0	6%	2%
Khuzestan	D2	60%DFL	ave BWA_{SW}	8%	76%	48%	24%	52%	5.9	7.2	4.8	1.0	69%	17%
Kohgiluieh	D3	60%DFL	min BWA_{SW}	4%	62%	49%	38%	51%	5.1	3.5	0.9	0.0	10%	0%

Kordestan	C3	75%DFL	min BWA_{SW}	3%	61%	61%	39%	39%	1.8	0.7	0.2	0.0	12%	0%
Lorestan	D3	60%DFL	min BWA_{SW}	3%	46%	21%	54%	79%	3.0	0.9	0.6	0.0	14%	1%
Markazi	C2	75%DFL	ave BWA_{SW}	4%	29%	26%	71%	74%	7.0	6.6	4.4	0.2	24%	9%
Mazandaran	B3	85%DFL	min BWA_{SW}	3%	68%	37%	32%	63%	4.2	0.4	2.6	0.0	5%	6%
NorthKhorasan	D2	60%DFL	ave BWA_{SW}	20%	58%	30%	42%	70%	7.2	6.6	5.4	1.1	90%	100%
RazaviKhorasan	C2	75%DFL	ave BWA_{SW}	3%	25%	22%	75%	78%	6.3	6.6	3.4	0.9	41%	17%
Semnan	C2	75%DFL	ave BWA_{SW}	3%	39%	26%	61%	74%	6.2	6.6	4.3	1.1	44%	33%
Sistan	C2	75%DFL	ave BWA_{SW}	2%	40%	43%	60%	57%	6.5	7.5	4.5	0.8	67%	0%
SouthKhorasan	D2	60%DFL	ave BWA_{SW}	12%	11%	15%	89%	85%	7.0	6.8	4.5	0.8	100%	100%
Tehran	D2	60%DFL	ave BWA_{SW}	16%	49%	31%	51%	69%	9.6	6.6	8.1	0.8	85%	100%
Yazd	C3	75%DFL	min BWA_{SW}	4%	14%	18%	86%	82%	3.6	2.1	0.3	0.0	58%	35%
Zanjan	C2	75%DFL	ave BWA_{SW}	5%	50%	53%	50%	47%	4.3	6.6	2.9	0.2	55%	0%

4.3.5 Analysis of EFR_{SW} and EFR_{GW} Violations in Specific Provinces

Figure 17 presents trade-offs between EFR_{SW} and EFR_{GW} violations in three specific provinces (Tehran, Hamedan and Gilan) under 12 scenarios. The provinces are selected based on the specific requirements: [1]Tehran has been selected which is suffering the most severe SWS and GWS to see how drastic BWC reduction may need to be made to reduce the EFR violations; [2]Hamedan has been chosen where BWA_{GW} is very significant as compared to BWA_{SW} to see how relevant it may be if BWA_{GW} is added in the cap setting [3]Gilan has been chosen because of the low SWS and GWS, this is to showcase how wide the uncertainty on EFR knowledge is.

The trade-off figures for Tehran clearly show that reducing SWC from max BWA_{SW} to min BWA_{SW} decreases EFR_{SW} violation by 55%. And the DFL should be lower than 75% (but with only 6% UFD) so that the EFR_{GW} violation can be reduced. If we cut down the DFL from 75% to 60%, then the violation value can be reduced by approximately 30%. These two sub-figures of Tehran indicate the importance of reducing BWC to lower than 75%DFL.

The trade-off figures for Hamedan present three main messages. First, a large EFR_{SW} violation reduction has been shown when the SWC reduces. Taking max BWA_{SW} as SWC results in 100% EFR_{SW} violation but only 5%-55% EFR_{GW} violation. Second, lowering the BWC can slightly reduce the EFR violations. EFR_{GW} violation decreases about 10%-35% when 40%BWC is cut down (with 11% UFD). Finally, these two sub-figures show a wide range of uncertainty in EFR_{GW} violation when using different EFR_{GW} methods to assess the EFR_{GW} violation. The resultant EFR_{GW} violation by taking EFR_{GW}-90% method is about 55% higher than the EFR_{GW} violation analyzed by taking EFR_{GW}-60% method. It reflects the importance of bringing groundwater resources into consideration in cap settings in Hamedan.

The trade-off figures for Gilan also show a large EFR_{SW} violation reduction when the SWC reduces. Taking max BWA_{SW} as SWC seems quite loose so that the EFR_{SW} violation is quite large. Because Gilan has such low SWS and GWS, no matter which BWC is set, Gilan has no EFR_{GW} violation under each scenario. These two sub-figures reflect that the current SWC which taking max BWA_{SW} as SWC is such a loose cap and a much stricter SWC needs to be made in Gilan. And it is better to set a more specific SWC for Gilan in the range of taking ave BWA_{SW} and min BWA_{SW}, this is the suggestion which is also mentioned in the previous section.

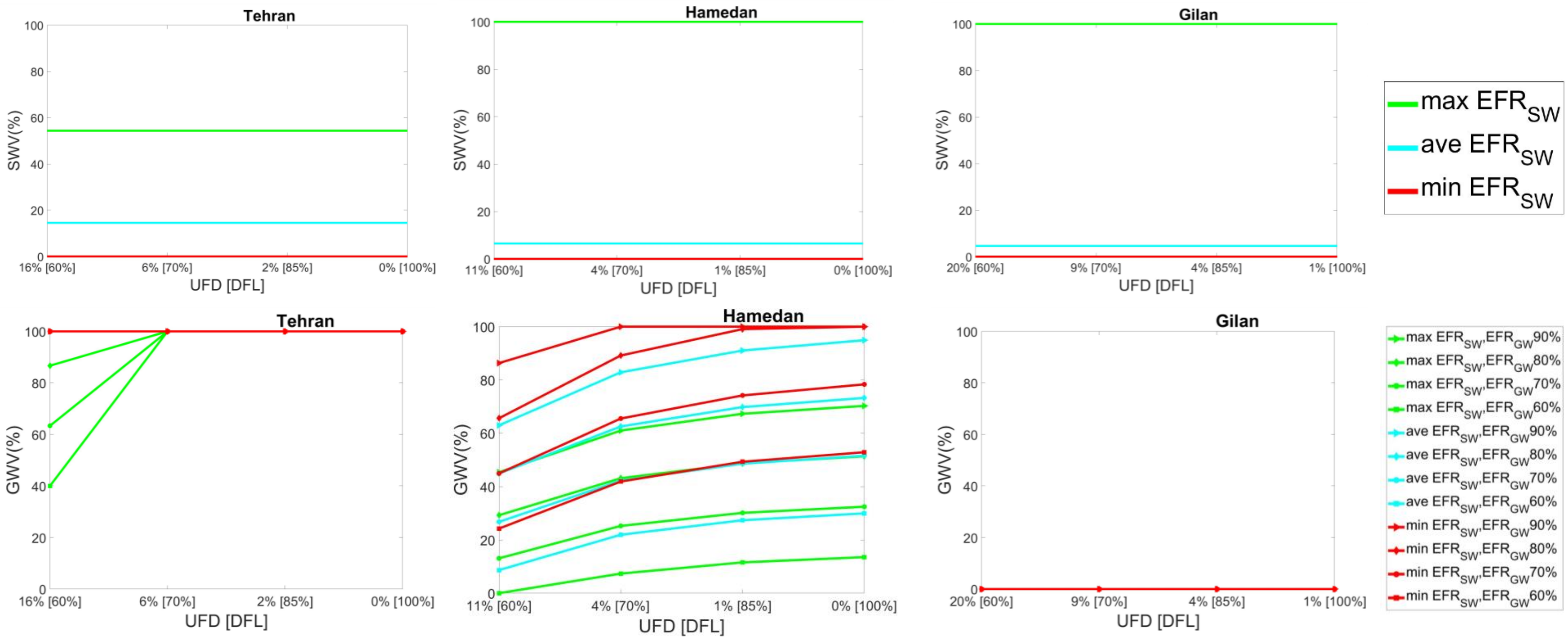

Figure 17. Trade-offs between EFR_{SW} and EFR_{GW} violations in Tehran, Hamedan and Gilan under 12 scenarios (Upper three sub-figures are the average values of monthly EFR_{SW} violations analyzed by six EFR_{SW} methods in certain provinces under each scenario, lower three sub-figures are EFR_{GW} violations analyzed by four EFR_{GW} methods in certain provinces under each scenario)

Chapter 5

Discussion

The given results are discussed in this chapter. In Section 5.1, the limitations and uncertainties of this research are discussed. Then some implications in cap setting are discussed in Section 5.2. Finally, some challenges and possible pathways are described in Section 5.3.

5.1 Limitations and Uncertainties

5.1.1 Method Variabilities and Uncertainties

The first limitation is the wide range of uncertainty in the estimated results by different EFR methods. The research adopts six EFR_{SW} methods and four EFR_{GW} methods to individually estimate the contribution of surface water and groundwater resources in EFRs. The variabilities and uncertainties are inevitable in the results. Richter method and Smakhtin method are much more conservative than other EFR methods, which result in a much higher boundary of EFR. Richter method has been used in various available BWF and BWS studies (Mekonnen, et al., 2012; Zhuo et al., 2019; Zhuo et al., 2016). In this research, Richter method affects the estimation of EFR_{SW}s into a relatively strict and precautionary standard, which is consistent with the discussed effects in the previous studies. Moreover, Pastor et al. (2014) proposed that there was a higher allocation of EFRs compared to the other methods when using flow quantile methods, such as Smakhtin method and Tennant method. These methods allocate lower EFRs during the high-flow season and higher EFRs during the low-flow season Pastor et al. (2014). The same situation occurs during EFR_{SW} estimating stage in this research, Tennant method addresses a large quantity of BWA_{SW} in the wet months, while addresses nearly no BWA_{SW} in the dry months. The estimated EFR_{SW}s therefore vary in different levels. In the global assessment by Hogeboom et al. (2020), 45%-55% of BWR_{SW} needs to be addressed as EFR_{SW} at the annual scale. In this research, by taking an average of EFR_{SW}s estimated by six EFR_{SW} values, the required annual EFR_{SW} is 53% of BWR_{SW}, which is exactly within the provided range by Hogeboom et al. (2020). As for groundwater, only a few papers present EFR_{GW} methods because of the difficulties to evaluate the dynamic groundwater-stream flow system. Gleeson et al. (2018) propose the most conservative method, which considerably drives the estimation of EFR_{GW} up.

Meanwhile, various EFR methods provide variable sustainability levels. Although taking the ensemble average value of results can theoretically reduce the methods' divergence, there is no doubt that the assessed sustainability levels spread to a substantial range. If we look at Figure 9 and Figure 10, the indicators for quantifying the current sustainability levels of the whole country have spread a considerable range across the average value. For example, BWA_{GW} spreads over $0.5 \times 10^{11} - 2 \times 10^{11}$ m^3 with the average value of 1.25×10^{11} m^3 in the year 1996. As a consequence, it would be better to firstly take a selection step to choose the proper EFR methods that fit the local circumstance. Raising a local-fit method to estimate EFRs is another feasible measure to reduce the uncertainties.

5.1.2 Data Limitations

The second limitation is the lack of temporal, spatial, and specific local context data in the research. Temporal data such as observed BWRs, domestic and industrial BWFs. BWRs data is missing during 2011-2014, while the BWFs data is available during this period. The lack of BWRs data may hide some important messages and even cause misjudgment. For instance, with only the year 2015's data available, it is hard to say if the year 2015 is a wet or dry year, it can therefore influence the judgment of demand satisfaction and cap setting. The domestic and industrial BWFs data is provided at annual scale but not at monthly scale. Although it may not have many effects on the final results because of the larger contribution of the agriculture sector in blue water consumption, it does affect the results when doing monthly assessments (Wada et al., 2014b). Averaging annual domestic and industrial BWFs into monthly values may underestimate the domestic and industrial contribution in EFR violations in the dry period and conversely overestimate it in the wet period.

The lack of spatial and specific local context data contains many aspects, such as not knowing lateral connections of the water system, exact GW-SW interactions, local ecological data and surface water storage (reservoir)'s presence and operation.

This research assesses the current blue water sustainability levels and set caps for different provinces, which can provide much convenience for the decision makers. However, it considers each province as a separate water system without lateral connections, thereby introducing more uncertainty in assessing blue water sustainability levels and cap settings. We suggest doing assessments and set caps at the basin and sub-basin scale and align with corresponding administrative jurisdictions in the further study (Zhuo et al., 2019).

The GW-SW interactions are quite complex, it is unknown that where groundwater does feed the baseflow and how groundwater storages can change the BWA pattern inter-annually. The groundwater storage is fed by groundwater recharge and drained by a reservoir coefficient that includes information on lithology and topography (Wada et al., 2014b), but such specific information is not known. Generally, the groundwater storage is a relatively important source of dry season flows (Pavelic et al., 2012), thus BWA_{GW} can consequently increase in the dry season. Nevertheless, excessive groundwater withdrawal can result in the groundwater table decline(Wada et al., 2012), which may gradually make the groundwater storage decrease by year, therefore may yet reduce the BWA_{GW} in the future.

The EFR_{SW} methods in this research are mainly the methods using hydrological data since only the hydrological data is available. The method such as Tennant method requires hydrological and ecological data, the lack of local ecological data may lead to uncertainties of EFR_{SW} estimations. Moreover, the reservoir effects on the flow distortions are also one of the important local contexts which need to be considered. The reservoir presence and operation can substantially change the BWA patterns and thus have effects on changing the blue water sustainability levels. Baldassarre et al. (2018) and Zhuo et al. (2019) also show that reservoirs can increase monthly BWA in dry months with the lowering BWA in wet months. Including reservoirs in the research can therefore relieve monthly SWS in dry months but may occasionally even add SWS in wet months.

5.1.3 Temporal and Spatial Resolution of Assessment

This research did a monthly assessment for surface water resources and an annual assessment for groundwater resources. The monthly SWS assessment does provide insight into SWS that is not revealed in annual SWS studies (Mekonnen, et al., 2012; Smakhtin et al., 2004), especially when SWS occurs in certain periods within one year. Nevertheless, the monthly assessment does not take hydrological years (wet and dry years) into consideration. Only the monthly assessment could not address inter-annual water availability and water scarcity. This may hide the fact that SWS gradually getting severe by year. Further study is required to also include the surface water resources' annual sustainability assessment.

Not only the temporal resolution should be discussed, but also the spatial resolution requires improvement. Combining Table 6 and Table 7 with Figure 17, quite different violation values are presented between values at the climate region scale and at the province scale. It can be concluded that higher resolution of violations analysis under scenarios is required to make more applicable results.

5.2 Implications of Setting Caps

This research proposes four BWC options, they are summarized after comparing the UFD results of ten different prior BWC options (with DFL = 100%, 95%, 90%, 85%, 80%, 75%, 70%, 65%, 60% and 50%). Our results showed that when DFL=100%, the annual demand is fully addressed; hence, there would be no month in which part of the demand is ignored. However, setting DFL to 50% means that only half of the highest monthly demand will be addressed; in this case, most of the months in the recent 10 years would remain thirsty. Since such consequences may raise enormous arguments by the consumers, and considering the gradual increase in BWFs by year, a larger amount of demand probably cannot be satisfied in the future, we limit ourselves to a DFL in the range of 60-100%. The cap options are defined based on those requirements which satisfy most of the demands in the wet years while it may not satisfy the demand in the dry months of a dry year. However, a BWF peak was shown in the year 2007, although it remained as a relatively wet year, the demand in the year 2007 was too large to satisfy (only the 100% DFL fully satisfies it). As a result, the UFD in 2007 is not fully considered when formulating BWC options. Meanwhile, the prior test showed that the UFD in dry months of a dry year ranged from 0%-15% when DFL=75%, which was considered to be acceptable. This research assesses the situation when DFL=100%, so the demand in the year with the highest annual demand is totally satisfied. Although setting such a cap is somewhat unreasonable, this scenario is included to raise human awareness that to what extent it will violate the environment if the demand is fully satisfied and to provide a reference for cap setting in the future. Because it has been foreseen a substantial growth in global water demand (Greve et al., 2018; Hogeboom et al., 2020; Kummu et al., 2016), and it is most realistic for such a place that already suffers BWS to agree on a BWC that gradually moves in time from the current BWF level down to a sustainable level (Hoekstra, 2019). This selecting procedure may not precisely and comprehensively assess all the possibilities, but indeed it gives a specific assessment of quantifying the demand fulfilment and the impacts on the environment with certain reasonable BWC options.

This research primarily sets total BWC and SWC, and then the corresponding groundwater limit can be known. Surface water limit is the first consideration in the research since in the reality, surface water resources are often the first water use to satisfy the demand and groundwater resources become the residual water use. The results showed that BWC reduction only contributes to slight violation reduction. Reducing 40% BWC only relieved a small amount of water scarcity with only one or two provinces presenting 50% relief in annual EFR violations. This may result from the monthly demand in the year with the highest annual demand is much higher than the monthly demand in other years. Most provinces showed the highest demand in the year 2007, while the national monthly demand in 2007 is 1.7 times the average year's monthly demand. Our suggestion is to set BWCs by taking a percentile value of long-term average monthly demands, although this value will also be increased by the year with quite large demands such as the year 2007 in Iran. Another suggestion is to take monthly demand in the year with 90% of the largest demand during the study period, this approach may help to eliminate the effects of the outlier such as the year 2007 on the average demand values. And it is also appropriate to set individual caps for wet years and dry years. However, altering SWC options has a large effect on changing violation, which may because the maximum and minimum BWA_{SW} are individually set as a SWC option. Although it remains a large difference when estimating EFR_{SW} violation, it is necessary to study these two SWC options' effects on EFR violation reduction. We suggest including more specific SWC options within this large range to provide more combinations of monthly SWC and GWC caps. And it would be applicable to offer a more feasible cap-option system for the decision makers to choose and implement.

The BWC setting requires more consideration and specific analysis just from water quantity perspective. For provinces that already suffer severe water scarcity, it is most urgent to agree on a BWC and the DFL should be constrained below such threshold, otherwise, it will not have many effects on violation reduction. Conversely, the looser cap could be set for provinces with moderate water scarcity. If the same strict DFL is set for each province, much water would remain unutilized in the areas where water is not scarce; if the same loose DFL is set, then the water-scarcity area would keep violating the environment. For provinces where BWA_{GW} is the first contributor of total available blue water, it would be a more reasonable choice to bring groundwater resources into the capping stage, as shifting the groundwater limit can make a much more difference in violation reduction than changing SWC. And because of the limited BWA_{SW}, accessible groundwater would be a choice to fill the gap between the increasing demand and limited BWA_{SW}, therefore it is necessary to put groundwater limit into the first consideration in such provinces.

5.3 Challenges and Pathways

Agriculture is the first contributor to blue water consumption and it is also the main sector that violates the environment. In the monthly assessment of EFR_{SW} violation, EFR_{SW} is 100% violated from June to September and agriculture contributes the most among the three sectors. Undoubtedly, sticking to the formulated caps may bring a big challenge to the water demand satisfaction, especially the water demand for agriculture, and it consequently results in economic loss with yield reduction. To reduce BWFs and realize maximum economic benefits, we suggest taking measures such as formulating WF benchmarks in crop production, modifying the current crop patterns, increasing irrigation efficiency and so on (Hoekstra, 2019; Karandish et al., 2018, 2020). Ideally, if future flows can be forecasted to some degree, a more dynamic system of formulating BWCs could be built, therefore more specific agriculture decisions could be made, for instance, which crop can be grown in which season.

Furthermore, if WF cap can be introduced into policy as a water management tool, it is inevitable to also take many factors into consideration such as legal, governance, social welfare, water use efficiency, equity and so on. We suggest designing an objective function that includes all these related values and quantitively analyzes the potential effects on each formulated cap. Therefore, setting WF caps at a local level is required towards policy uptake.

Chapter 6

Conclusions

This study shows a more comprehensive picture of the current blue water sustainability levels in Iran and formulates variable BWC options for Iran's provinces and climate zones. It gives people insights into the current situation of Iran's blue water and provides possible BWC options for blue water management in Iran.

This study first uses six EFR_{SW} methods and four EFR_{GW} methods to respectively evaluate monthly surface water's and annual groundwater's contribution in EFRs for each province and climate zone in Iran. Then the current blue water sustainability level is assessed by evaluating BWS and EFR violations for each province and each month during 1981-2015. Furthermore, twelve scenarios regarding BWC setting options are formulated by changing DFLs and BWA_{SW}s.

According to the results, 53% of BWR_{SW} at monthly scale and 75% of BWR_{GW} at annual scale should be allocated as EFRs on average, while the hotspots of Iran increased from 9 to 20 in 1981-2015 because of rapid growth in BWFs. Therefore, this study formulates several cap options and proposes an appropriate set of provincial caps in order to limit the current BWFs. Among twelve scenarios, Scenario C is assessed to be a level that can satisfy most of the months' demand during the study period. To address trade-offs between violating EFR_{SW}s and constraining groundwater use, split SWC and GWC options are established at monthly scale. The composition of surface water and groundwater resources has been redistributed after cap setting. Although groundwater resources are shown to be the first contributor in most of the provinces especially in BWA_{GW} – rich provinces, the impacts on EFR_{GW}s can be reduced by maximumly 67% among provinces in Iran under the suggested caps. Nevertheless, to preferentially prevent surface water resources from being violated, EFR_{GW}s violations will slightly be reduced or even be higher in water-scarce provinces after cap setting, the suggestion is to set stricter BWCs and GWCs for these provinces.

This cap-setting procedure results in one main point that changing BWA_{SW} plays a big role in affecting the resultant EFR violations while cutting down BWCs only presents a slight relief annually. This may result from high monthly demand in the year with the highest annual demand and the large range of SWC options that are taken in the research. Further studies are required to establish more specific BWCs and SWCs within a smaller range. It is also worth considering groundwater resources as the first water use and set GWCs in the first stage especially in BWA_{GW} – dominant areas.

This study is the first research that takes groundwater footprint into consideration and establishes BWCs at provincial scale and climate region scale. It provides a good reference of setting BWCs in reality's water management. This study is also a good start of doing researches on setting certain BWF ceilings for certain areas.

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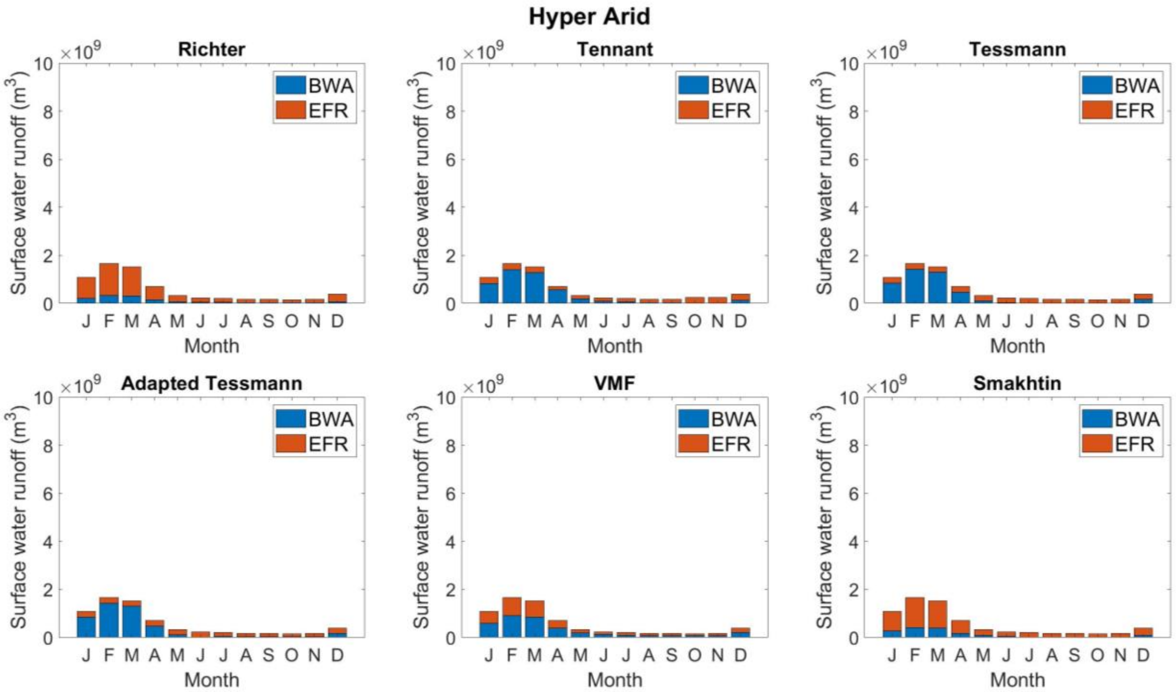
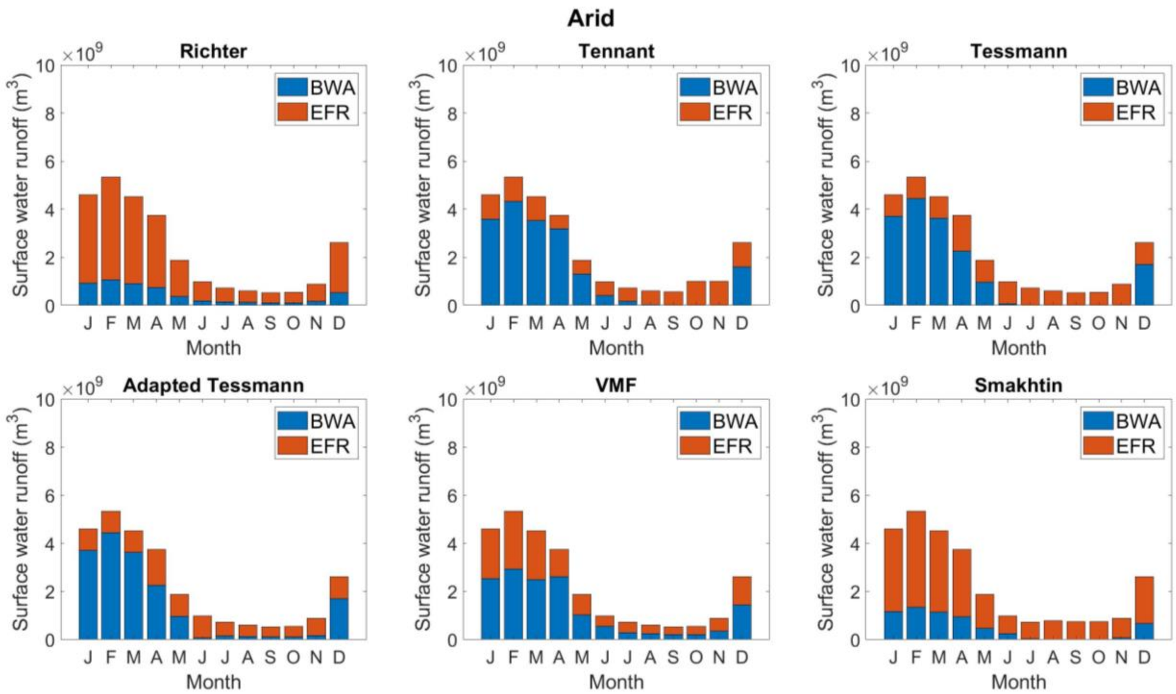
Appendix A

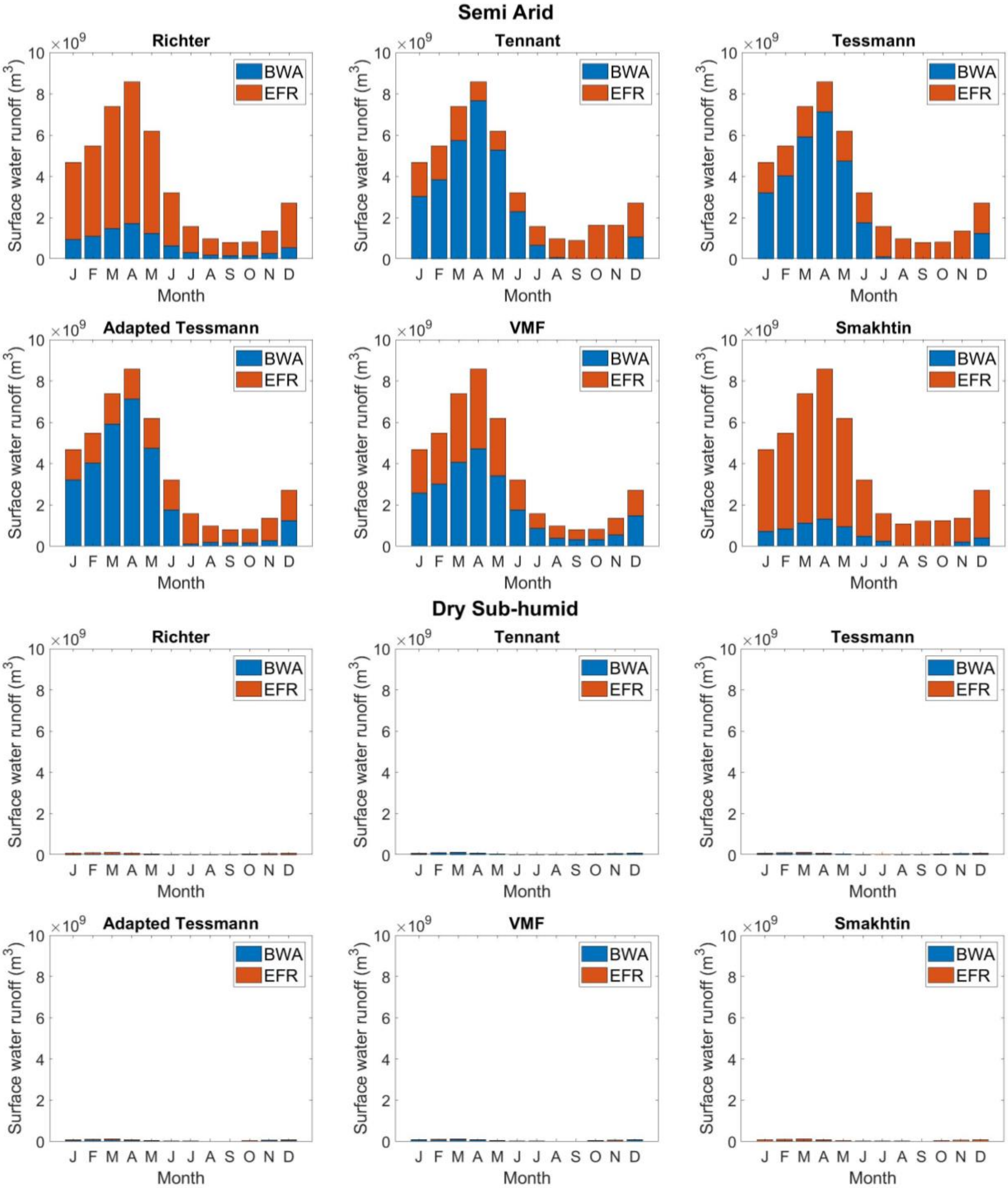
Current blue water sustainability levels

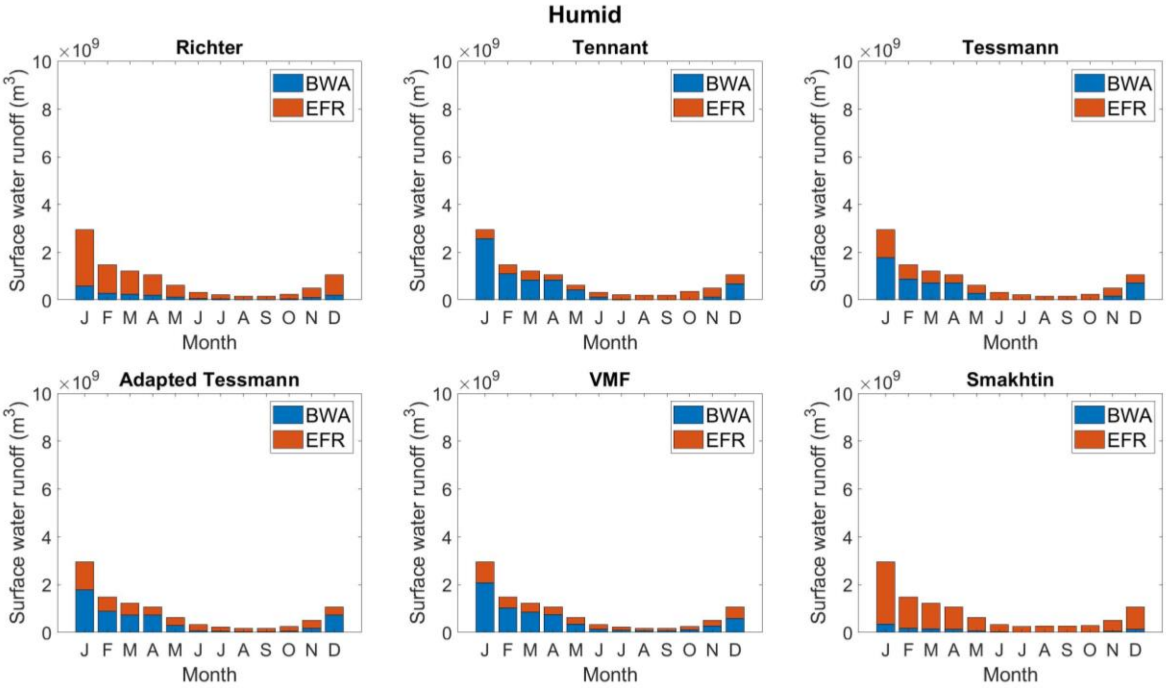
A.1 EFR VS. BWA in climate zones

- Surface Water:

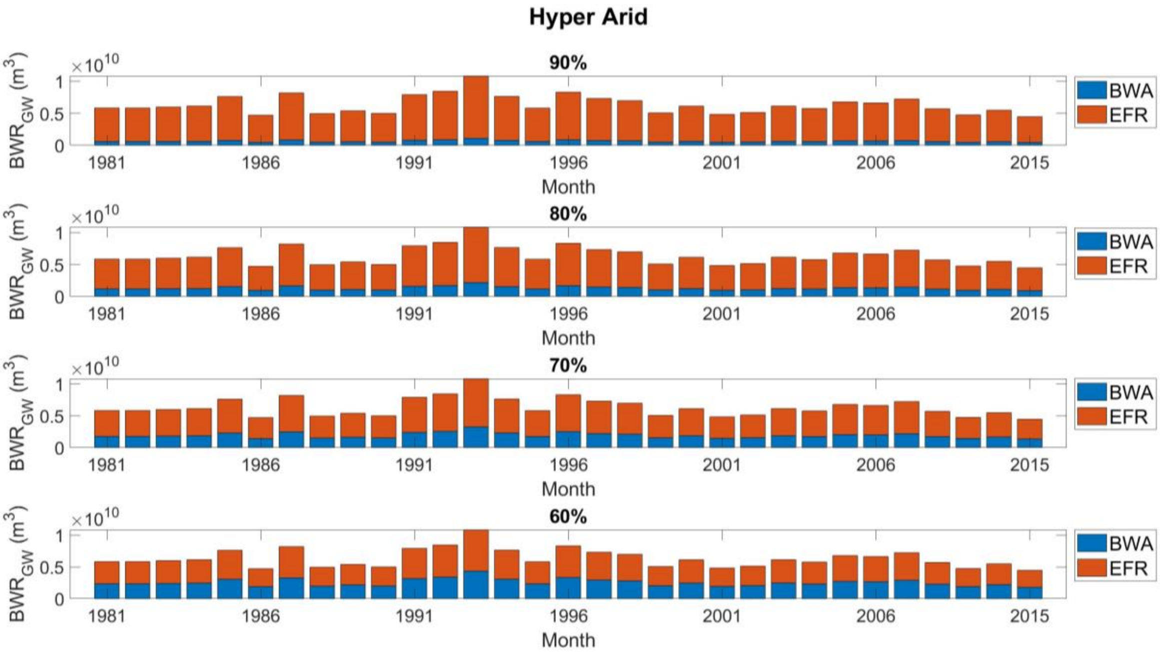




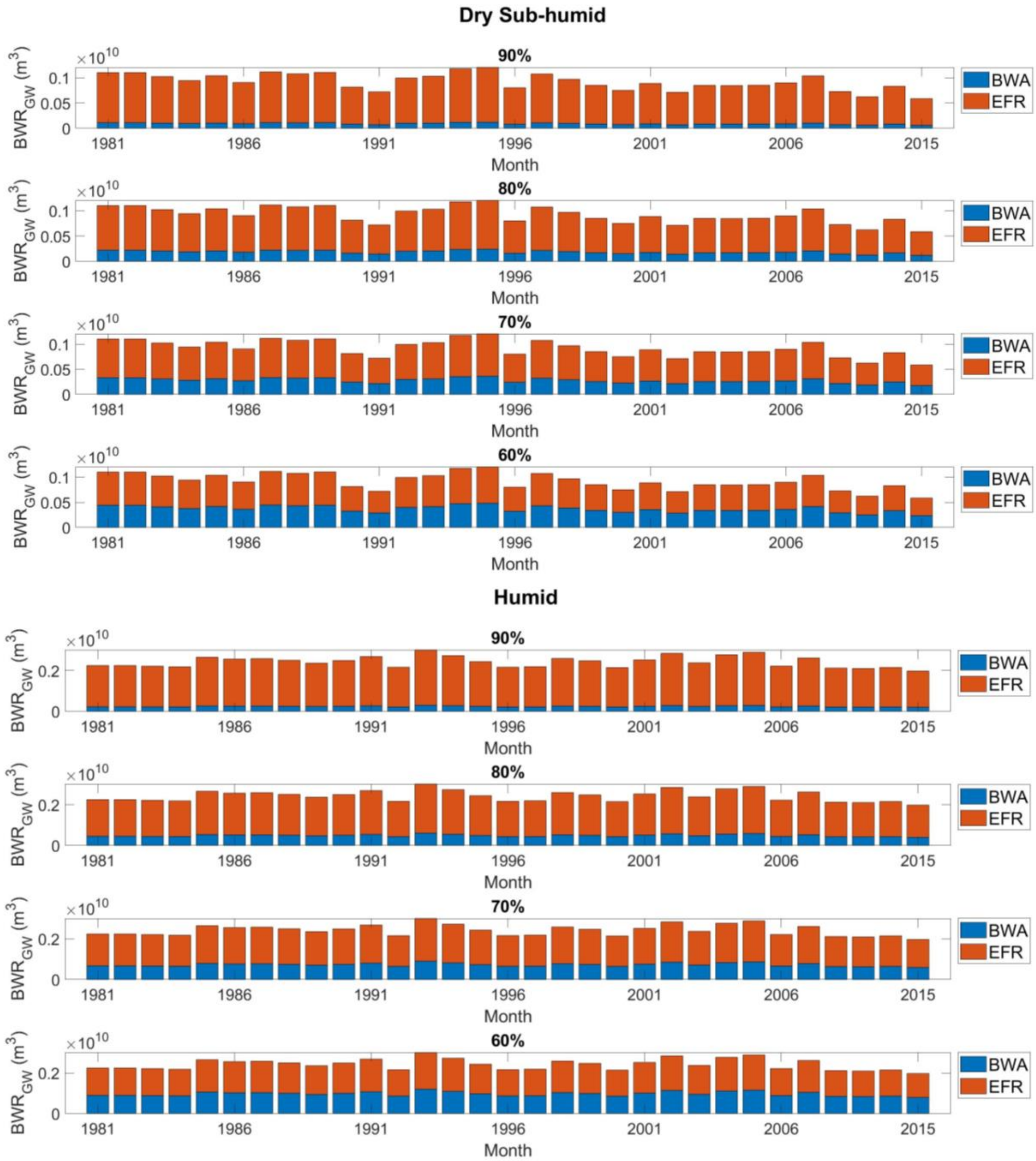

Semi Arid
Richter
Tennant
Tessmann
Adapted Tessmann
VMF
Smakhtin
Dry Sub-humid
Richter
Tennant
Tessmann
Adapted Tessmann
VMF
Smakhtin
BWA
EFR
Surface water runoff (m^3)
$\times 10^9$
Month
J F M A M J J A S O N D



- Groundwater:



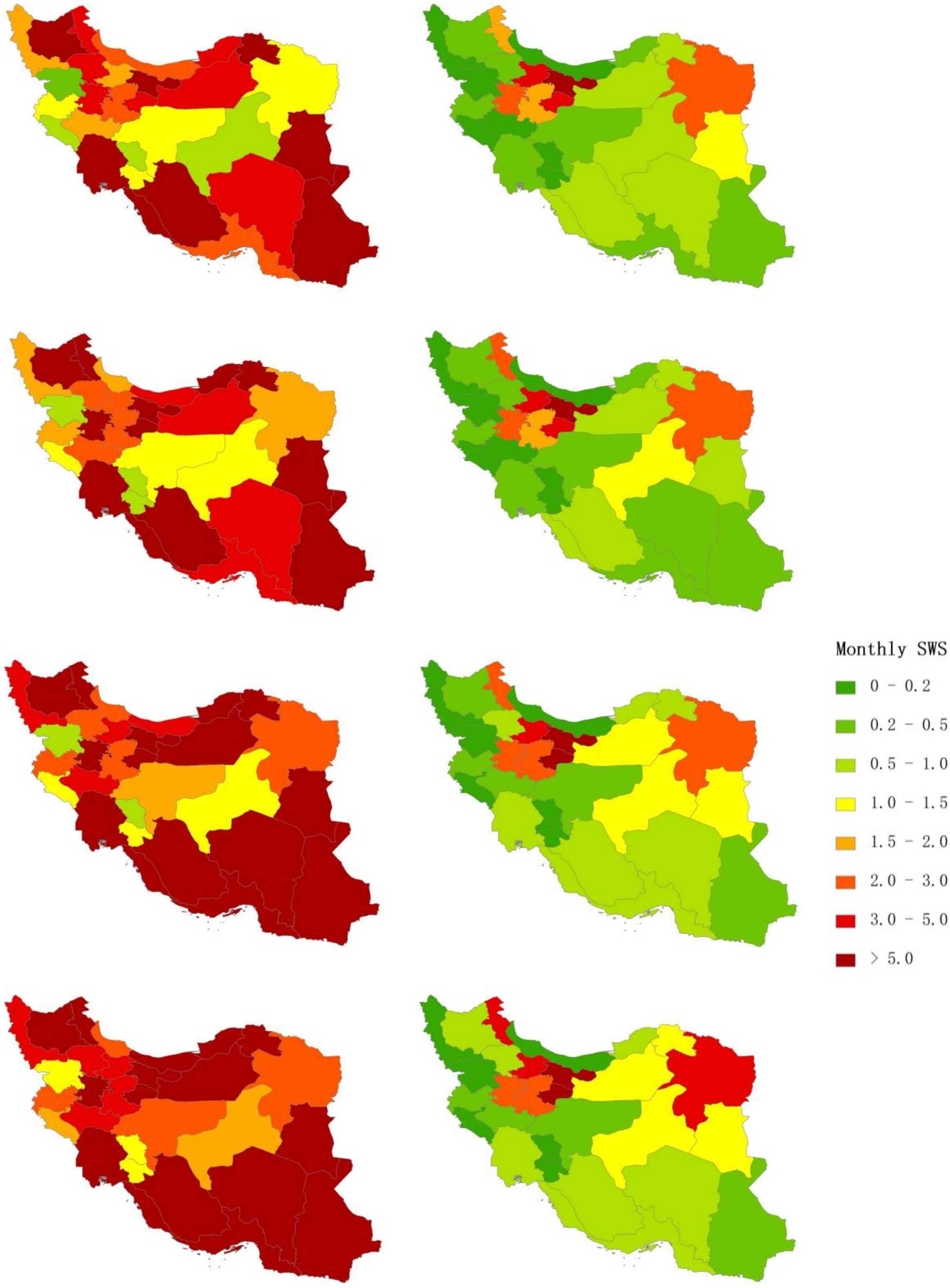

Arid
90%
80%
70%
60%
Semi Arid
90%
80%
70%
60%
×10^10
BWR_GW (m^3)
BWA
EFR
1981
1986
1991
1996
2001
2006
2015
Month


Dry Sub-humid
90%
80%
70%
60%
Humid
90%
80%
70%
60%
BWR_{GW} (m^3)
$\times 10^{10}$
0
0.05
0.1
0.2
1981
1986
1991
1996
2001
2006
2015
Month
BWA
EFR

A.2 Spatial variation of BWS

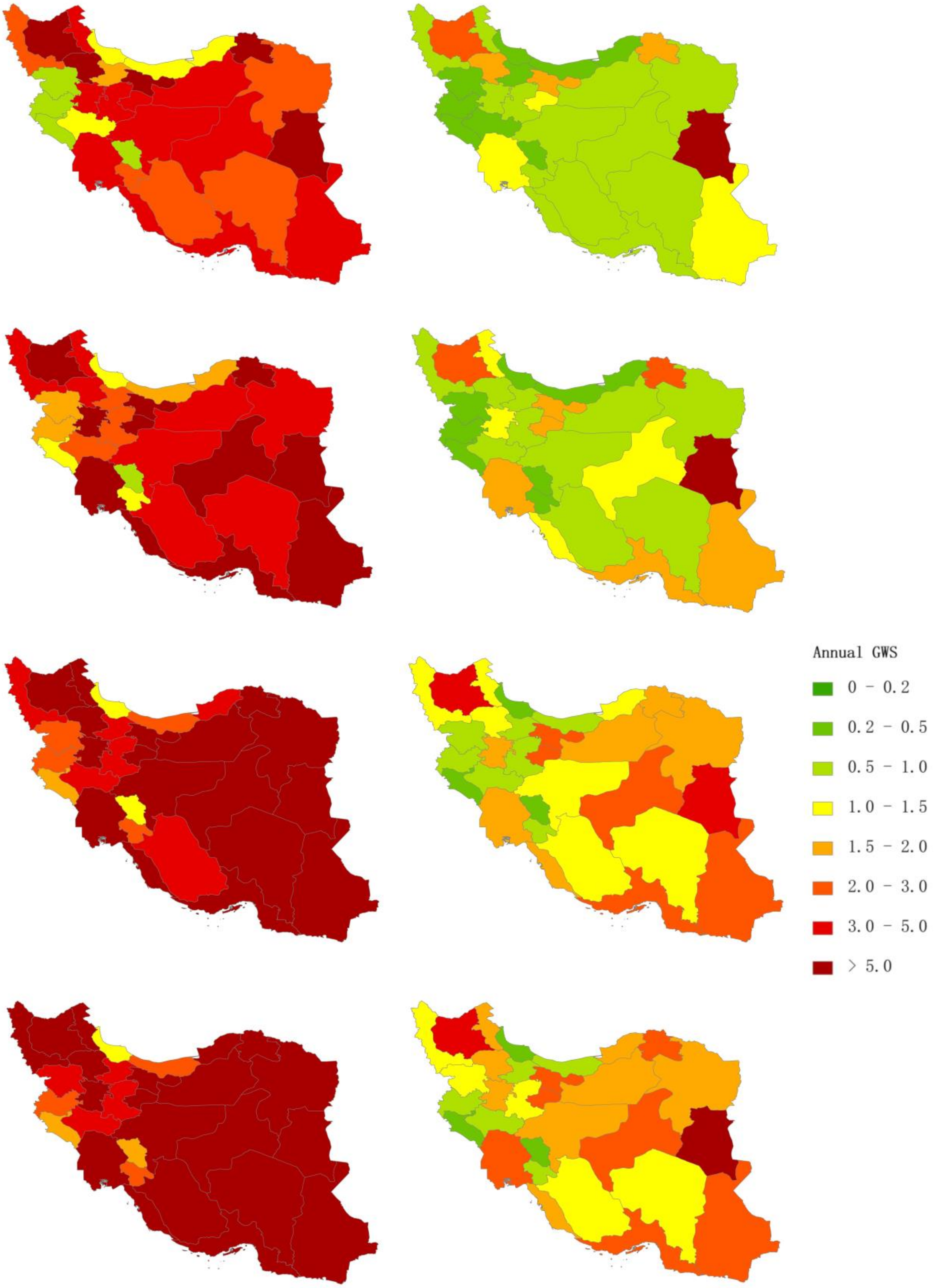
- Monthly SWS in dry and wet months in 1981-2015 (10-year average)

Dry: **Wet:**



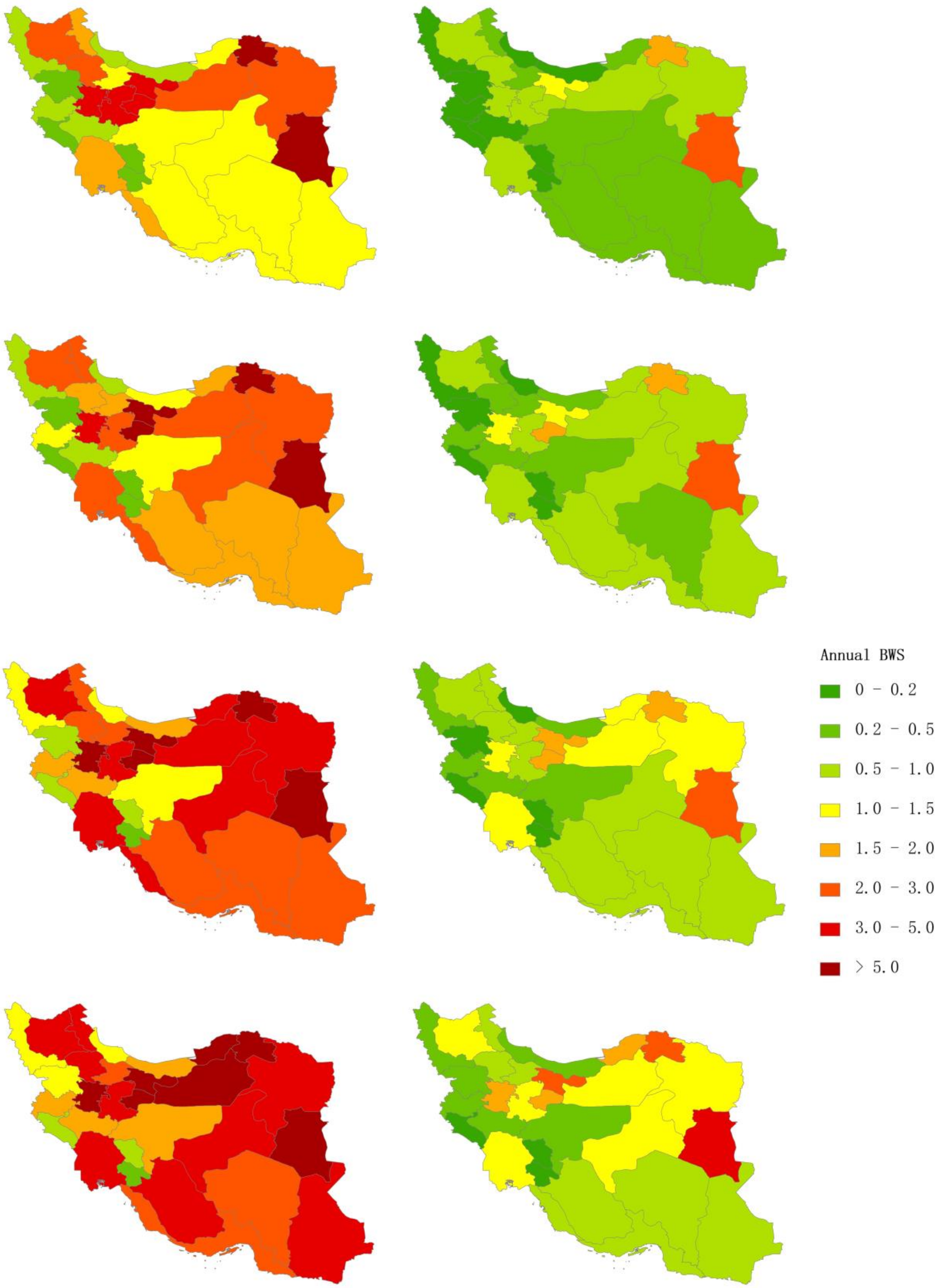
- Max and Min value of evaluated annual GWS in 1981-2015 (10-year average)

Max: **Min:**



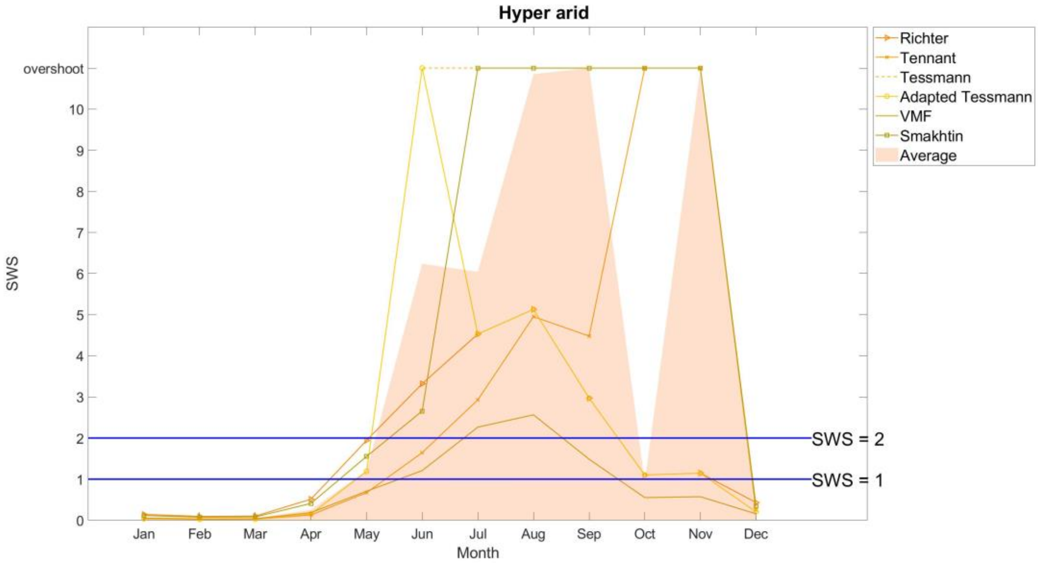
- Max and Min value of evaluated annual BWS in 1981-2015 (10-year average)

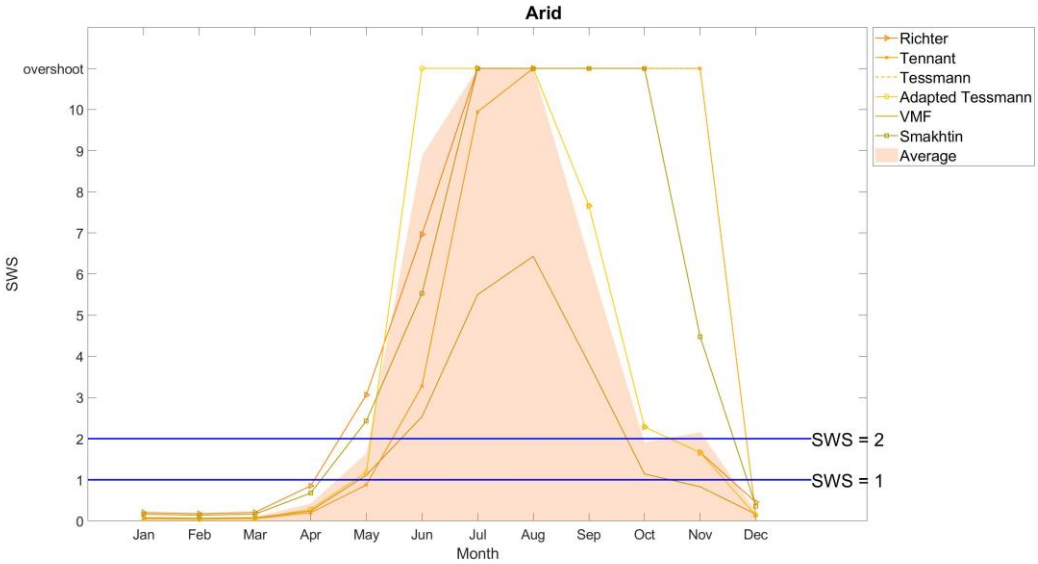
Max: **Min:**

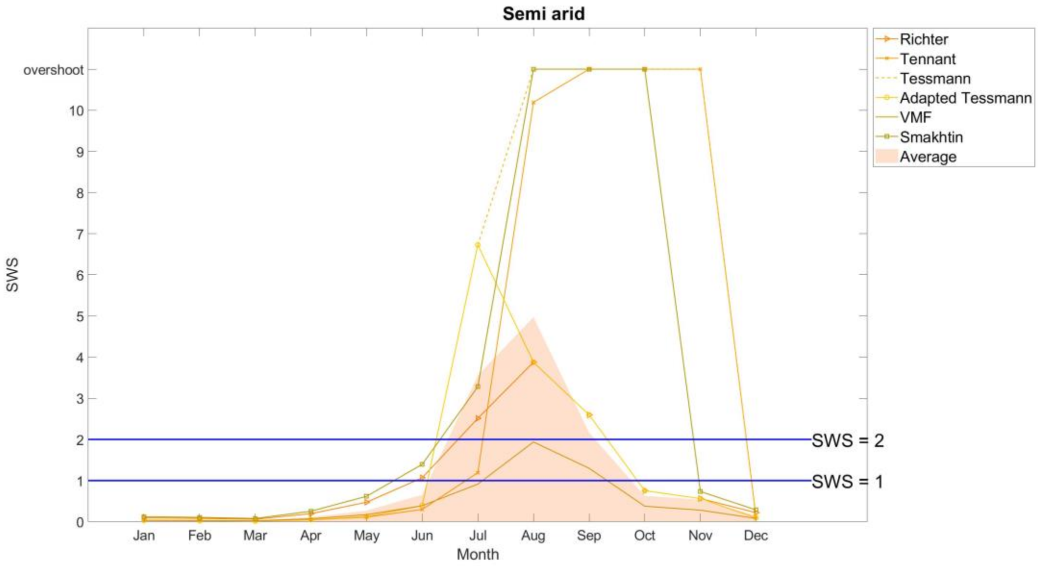


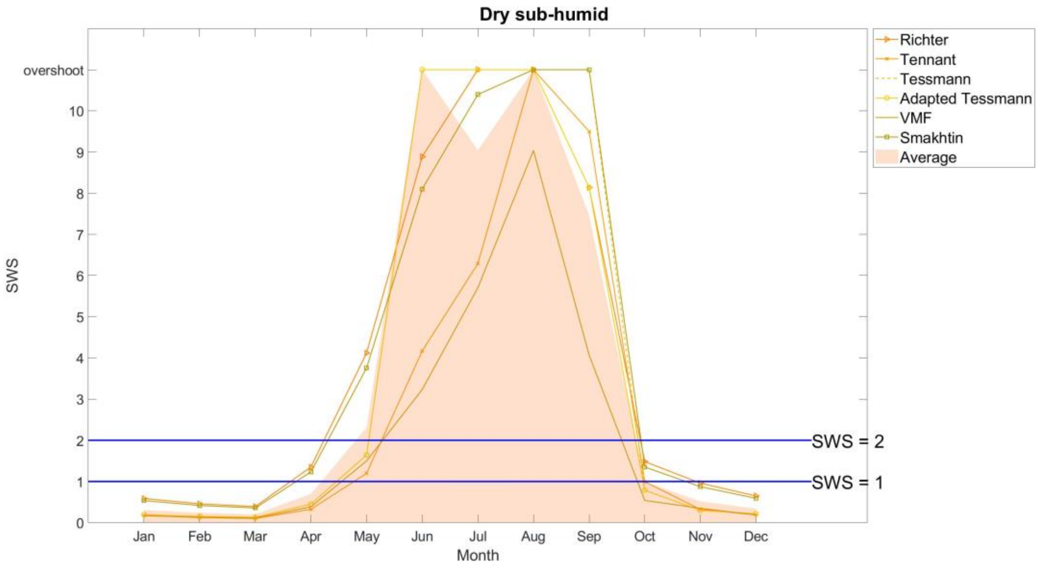
A.3 Temporal variation of BWS

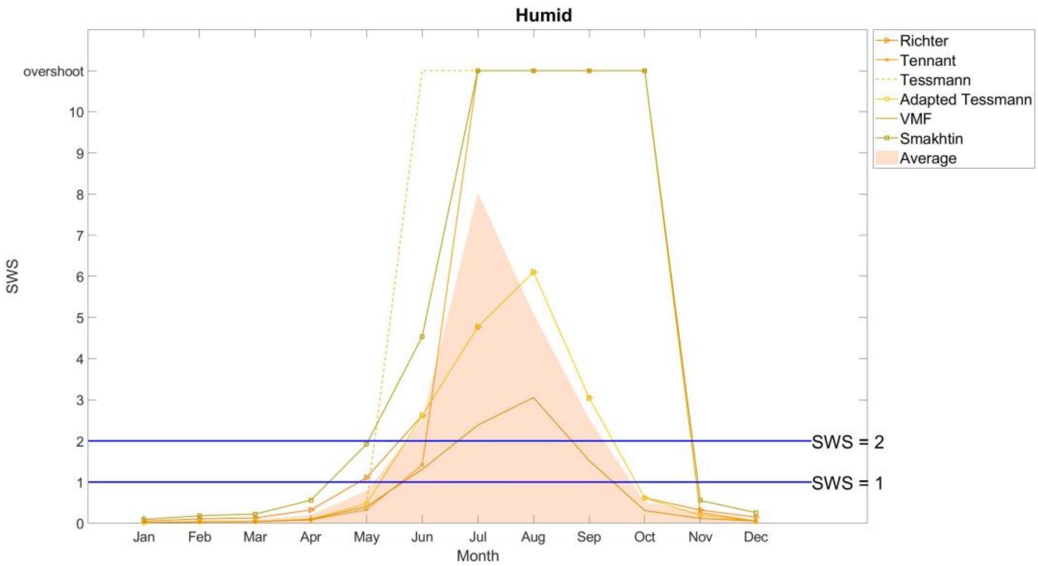
- Monthly SWS of each climate zone in 1981-2015



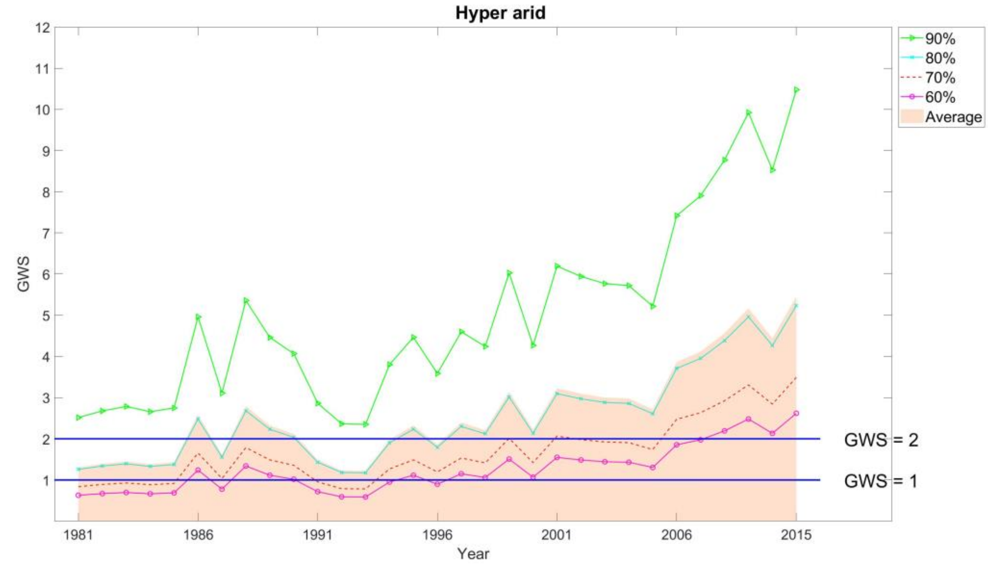


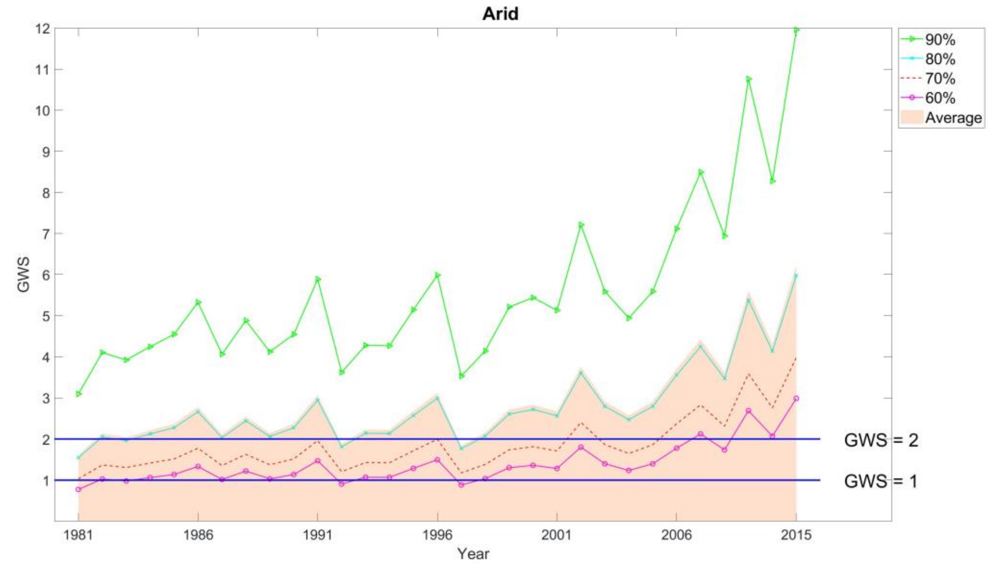

Semi arid
SWS
overshoot
10
9
8
7
6
5
4
3
2
1
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month
SWS = 2
SWS = 1
Richter
Tennant
Tessmann
Adapted Tessmann
VMF
Smakhtin
Average

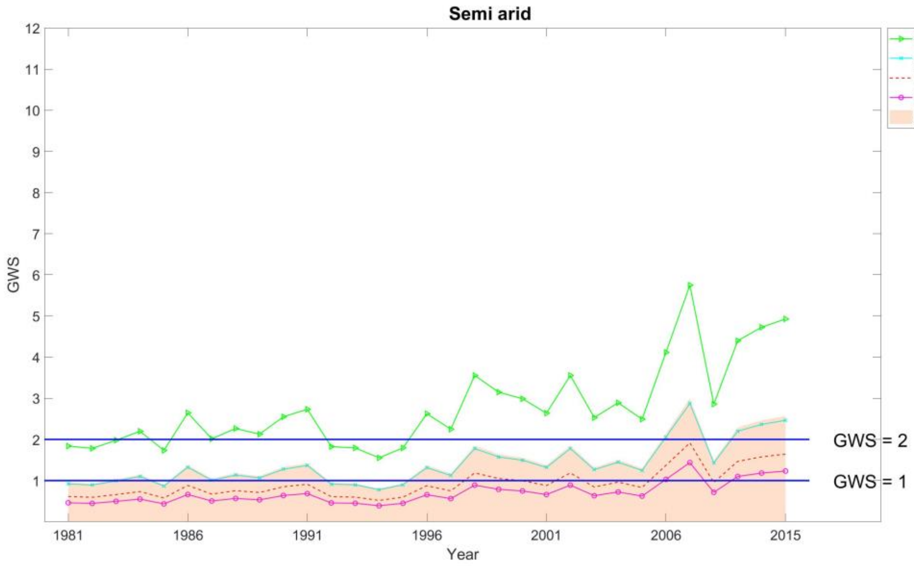

Dry sub-humid
SWS
overshoot
10
9
8
7
6
5
4
3
2
1
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month
SWS = 2
SWS = 1
Richter
Tennant
Tessmann
Adapted Tessmann
VMF
Smakhtin
Average

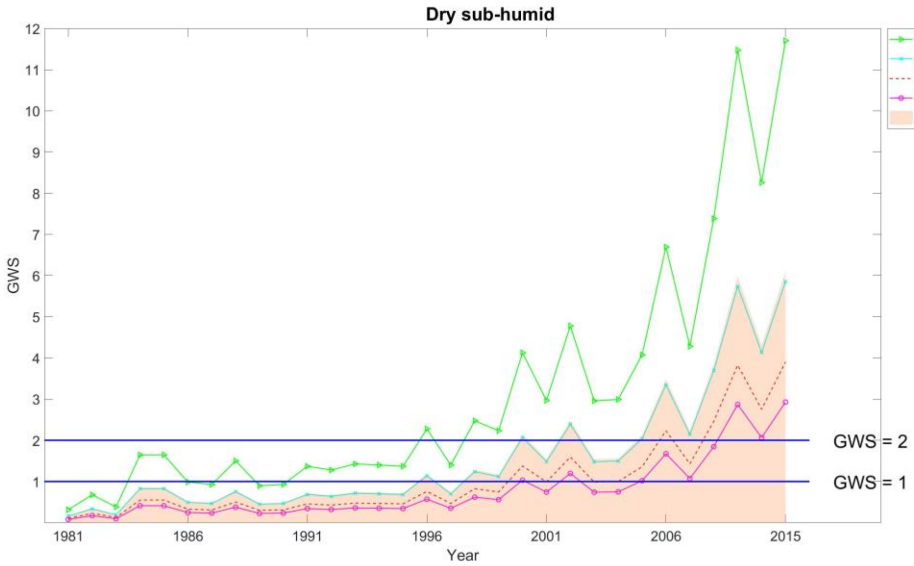

Humid
SWS
overshoot
10
9
8
7
6
5
4
3
2
1
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month
SWS = 2
SWS = 1
Richter
Tennant
Tessmann
Adapted Tessmann
VMF
Smakhtin
Average

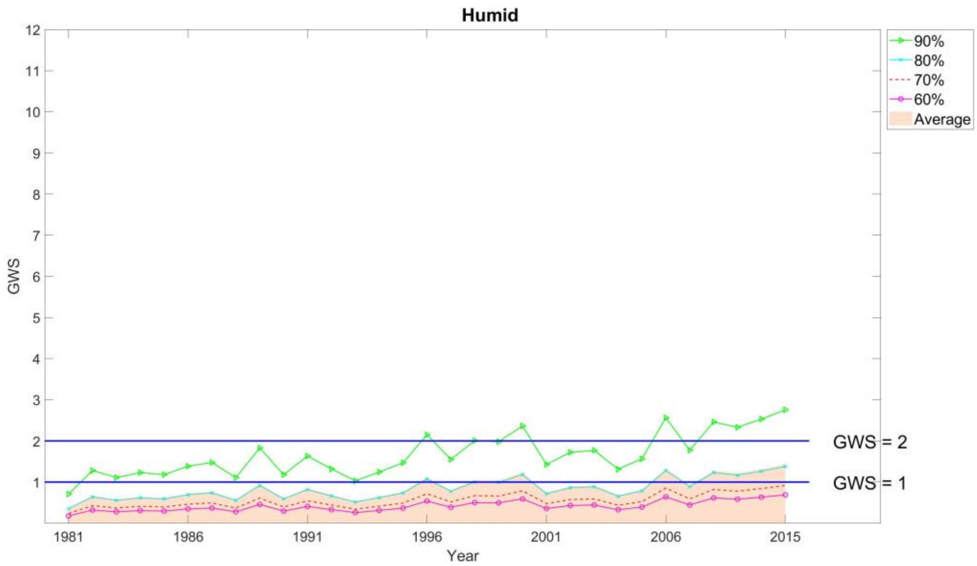
- Annual GWS of each climate zone in 1981-2015





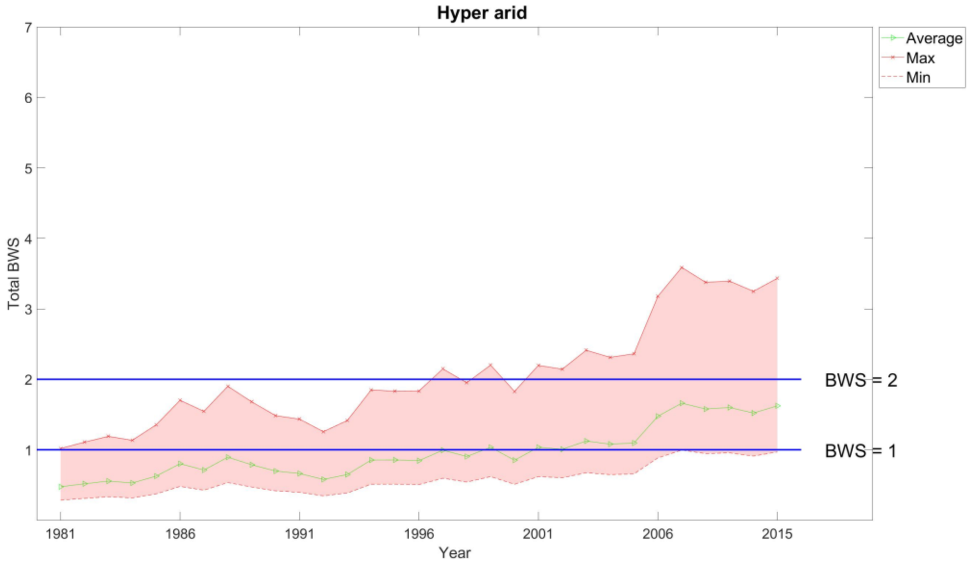

Semi arid
GWS
Year
90%
80%
70%
60%
Average
GWS = 2
GWS = 1

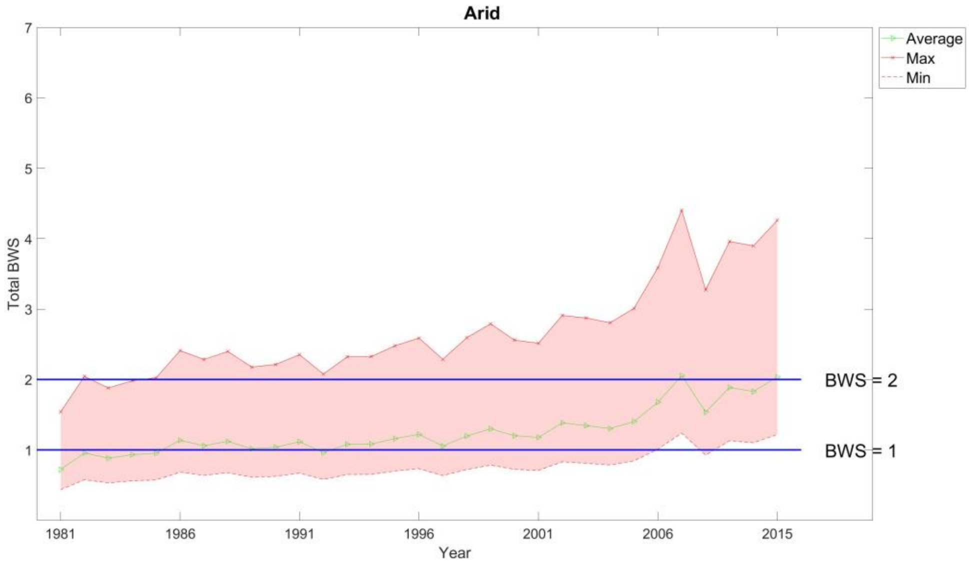

Dry sub-humid
GWS
Year
90%
80%
70%
60%
Average
GWS = 2
GWS = 1

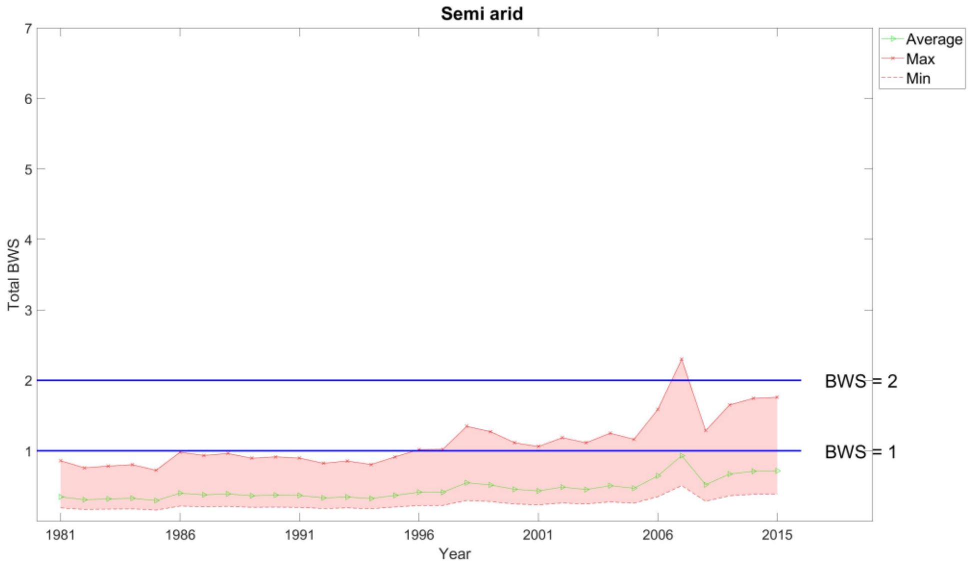

Humid
GWS
Year
90%
80%
70%
60%
Average
GWS = 2
GWS = 1

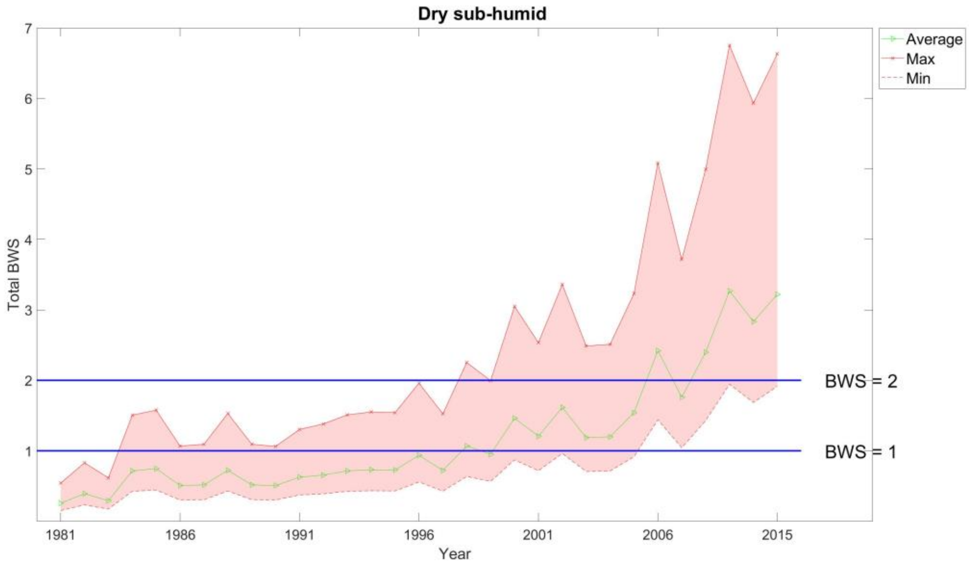
.

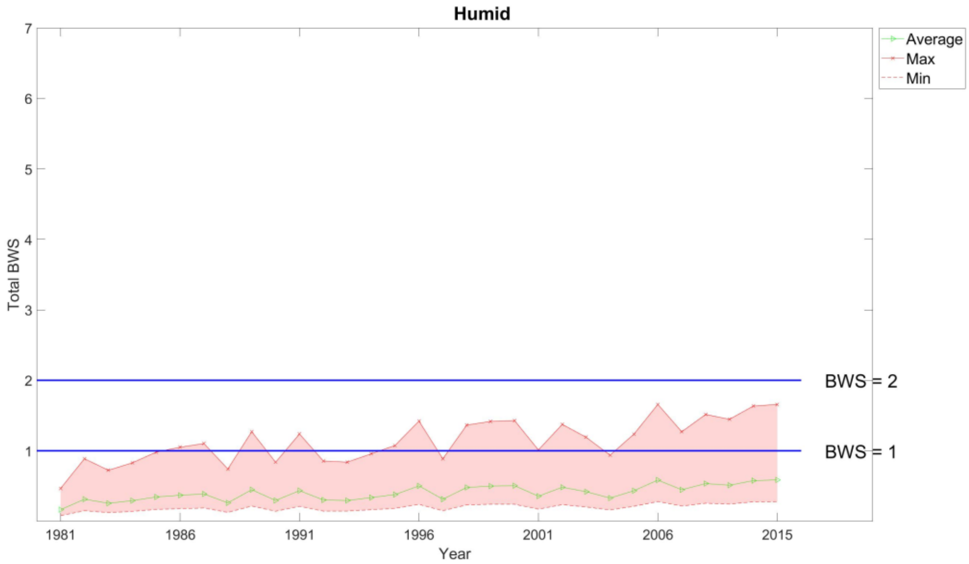
- Annual BWS of each climate zone in 1981-2015





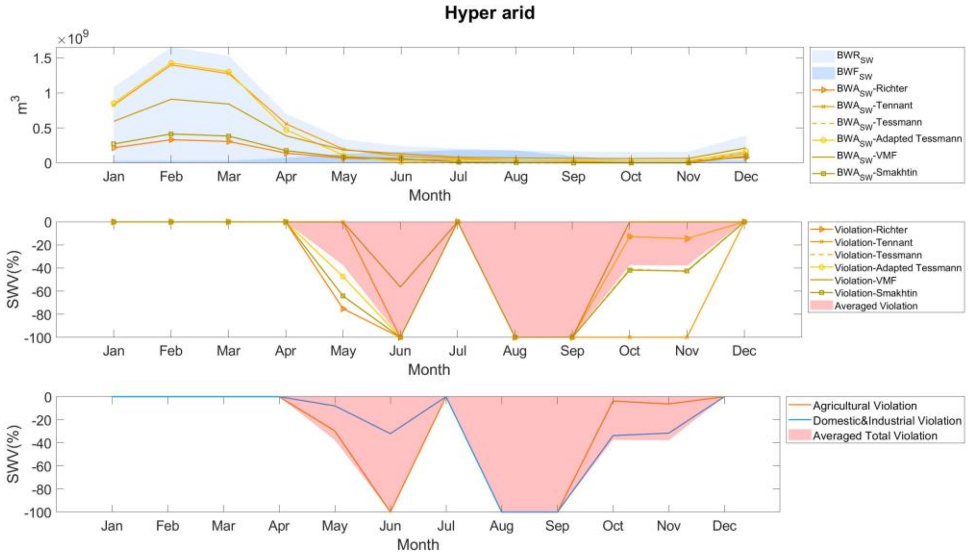

Semi arid
Total BWS
Year
Average
Max
Min
BWS = 2
BWS = 1
1981
1986
1991
1996
2001
2006
2015

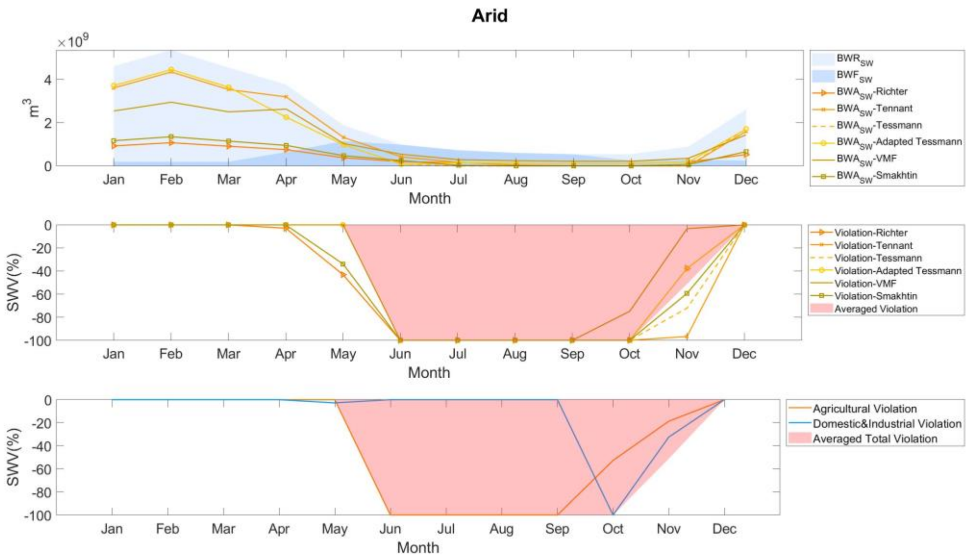

Dry sub-humid
Total BWS
Year
Average
Max
Min
BWS = 2
BWS = 1
1981
1986
1991
1996
2001
2006
2015

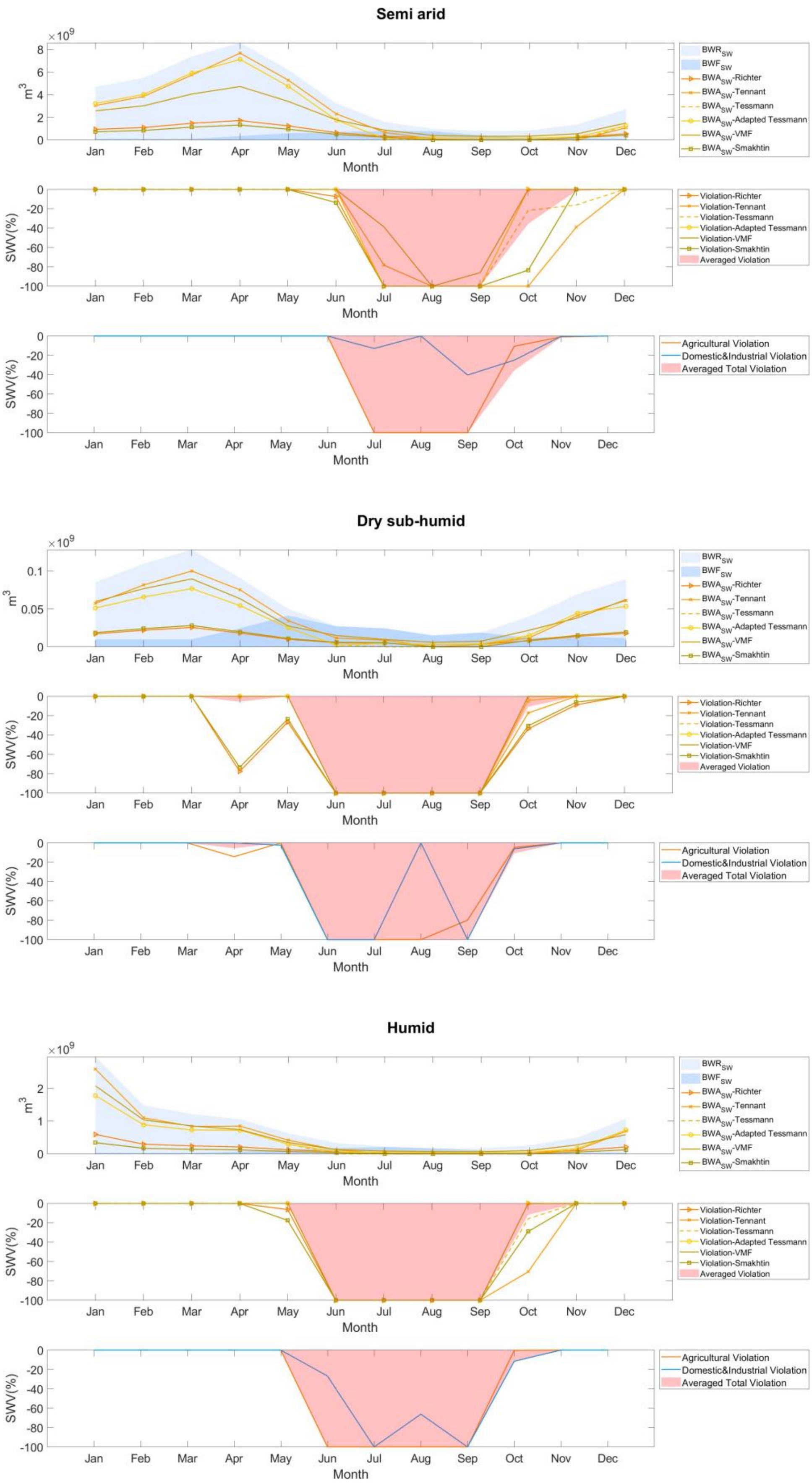

Humid
Total BWS
Year
Average
Max
Min
BWS = 2
BWS = 1
1981
1986
1991
1996
2001
2006
2015

A.4 Temporal variation of surface water violation

- Monthly EFR violation by surface water resources of each climate zone in 1981-2015

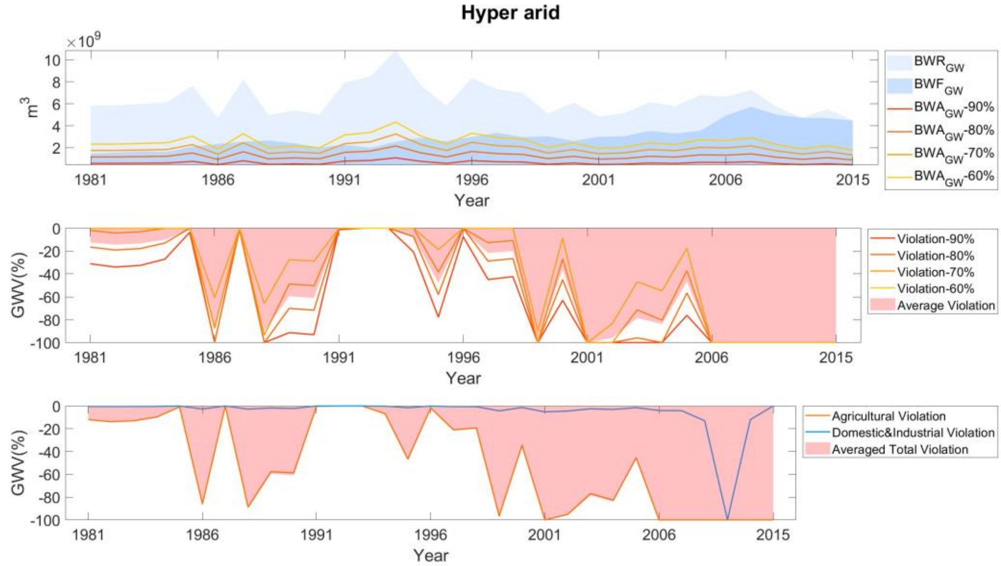


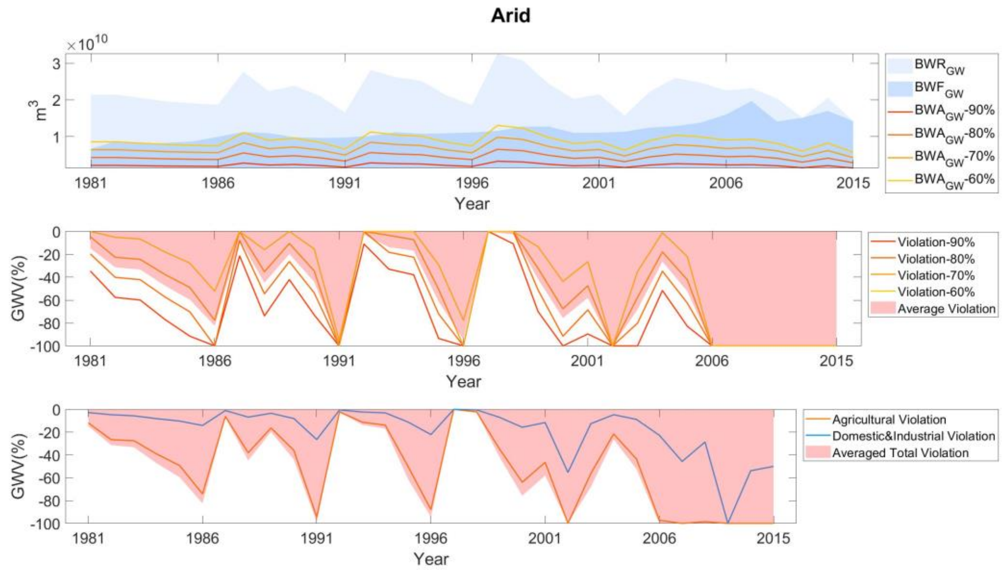




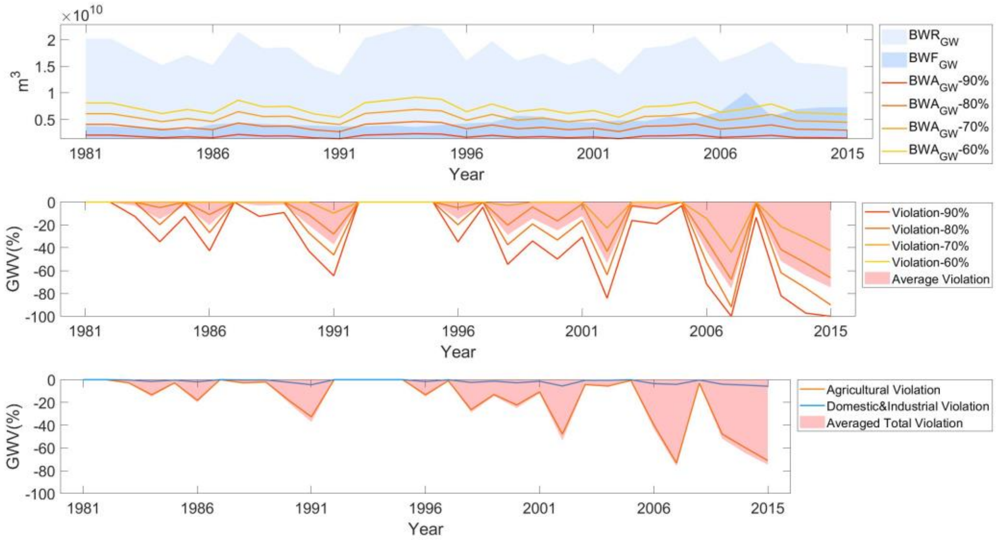
Semi arid
×10^9
m^3
Month
SWV(%)
BWR_SW
BWF_SW
BWA_SW-Richter
BWA_SW-Tennant
BWA_SW-Tessmann
BWA_SW-Adapted Tessmann
BWA_SW-VMF
BWA_SW-Smakhtin
Violation-Richter
Violation-Tennant
Violation-Tessmann
Violation-Adapted Tessmann
Violation-VMF
Violation-Smakhtin
Averaged Violation
Agricultural Violation
Domestic&Industrial Violation
Averaged Total Violation
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Dry sub-humid
Humid

- Annual EFR violation by groundwater resources of each climate zone in 1981-2015

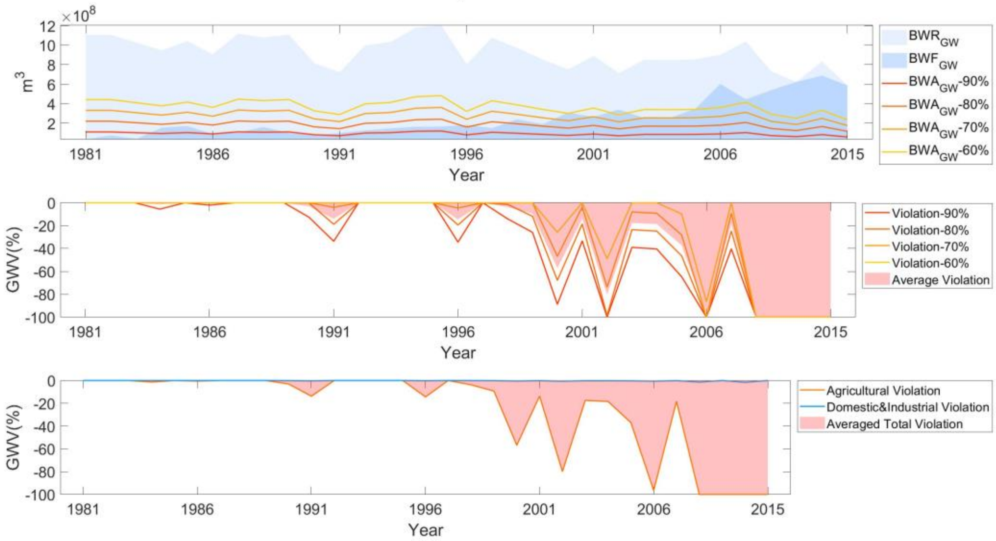




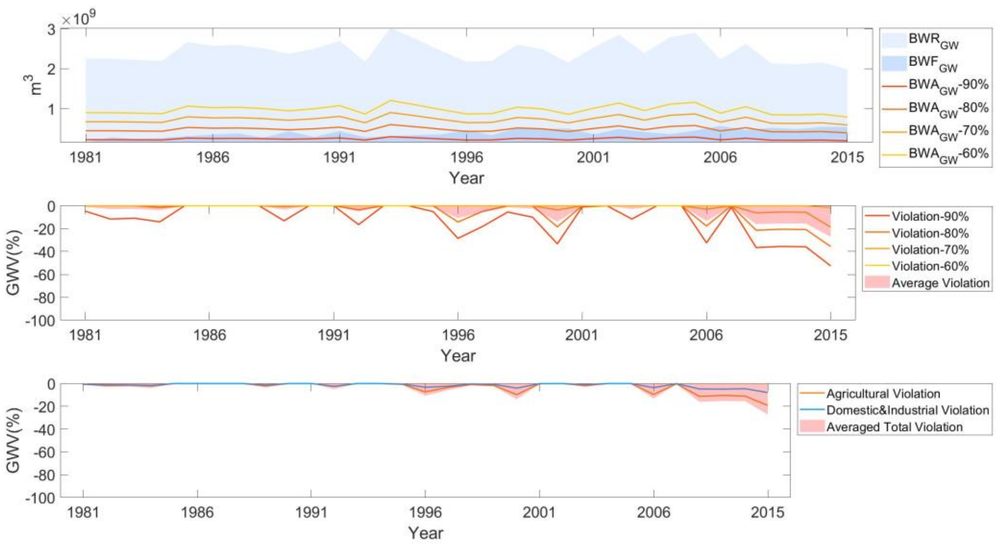
Semi arid



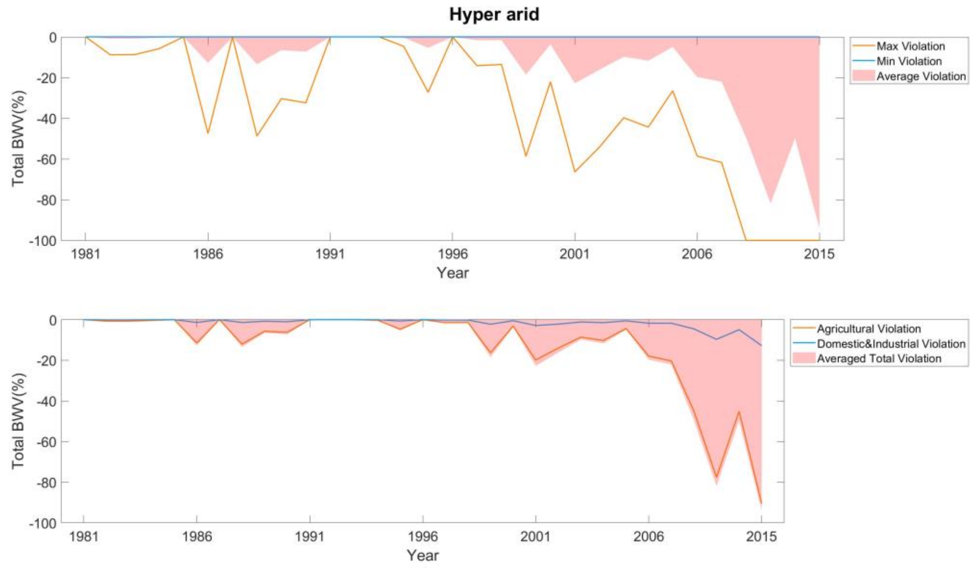
Dry sub-humid

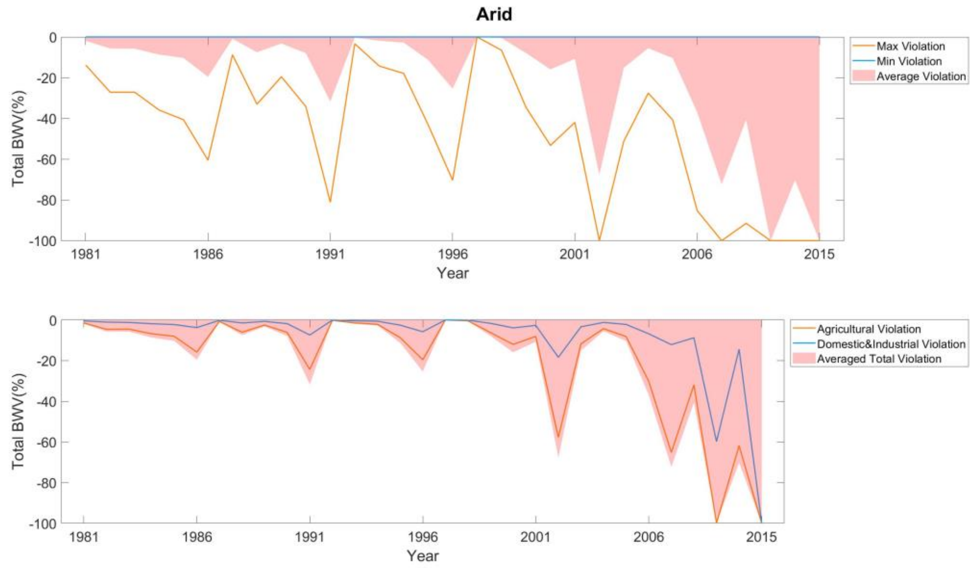


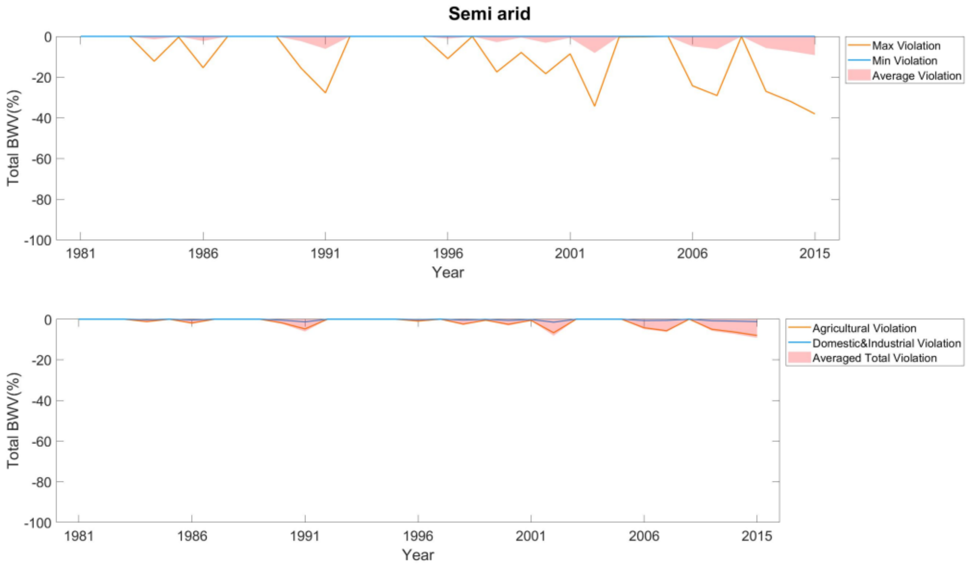
Humid

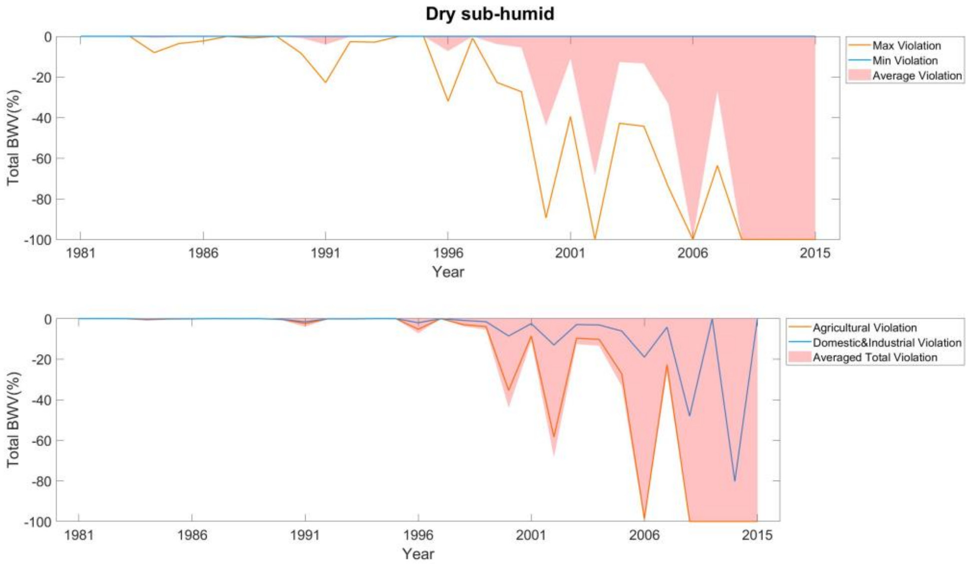


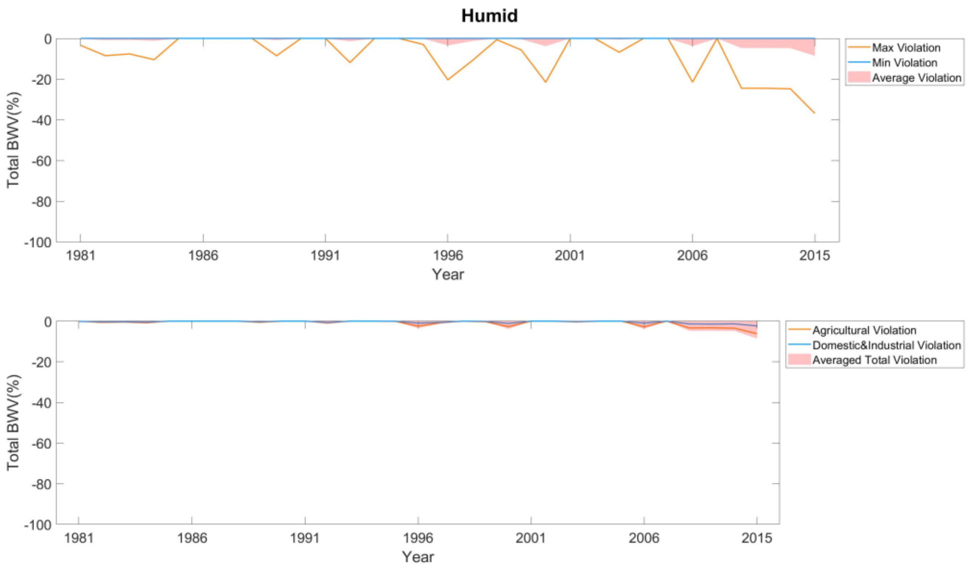
- Annual EFR violation by total blue water of each climate zone in 1981-2015






Semi arid
Total BWV(%)
Year
Max Violation
Min Violation
Average Violation
Agricultural Violation
Domestic&Industrial Violation
Averaged Total Violation


Dry sub-humid
Total BWV(%)
Year
Max Violation
Min Violation
Average Violation
Agricultural Violation
Domestic&Industrial Violation
Averaged Total Violation

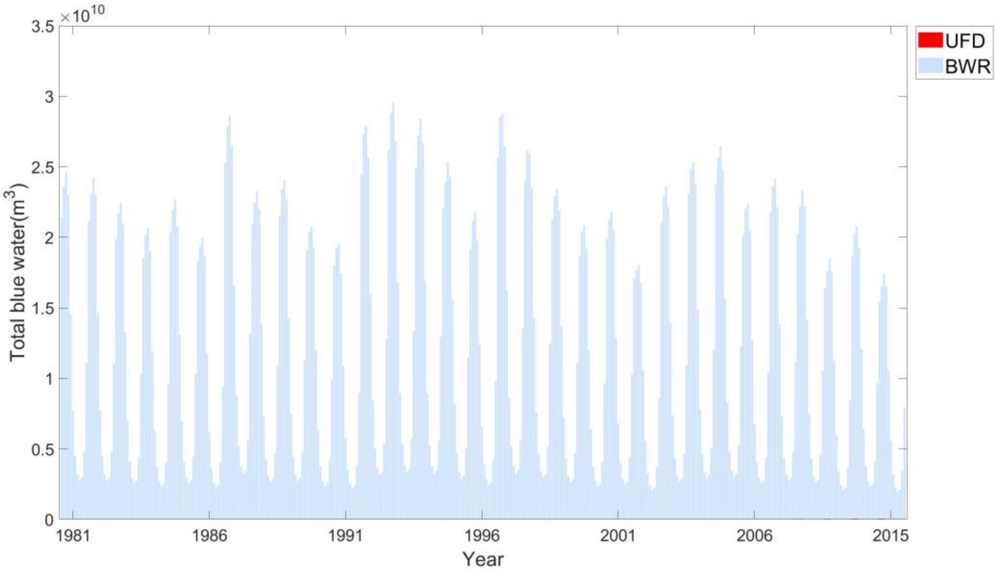

Humid
Total BWV(%)
Year
Max Violation
Min Violation
Average Violation
Agricultural Violation
Domestic&Industrial Violation
Averaged Total Violation

Appendix B

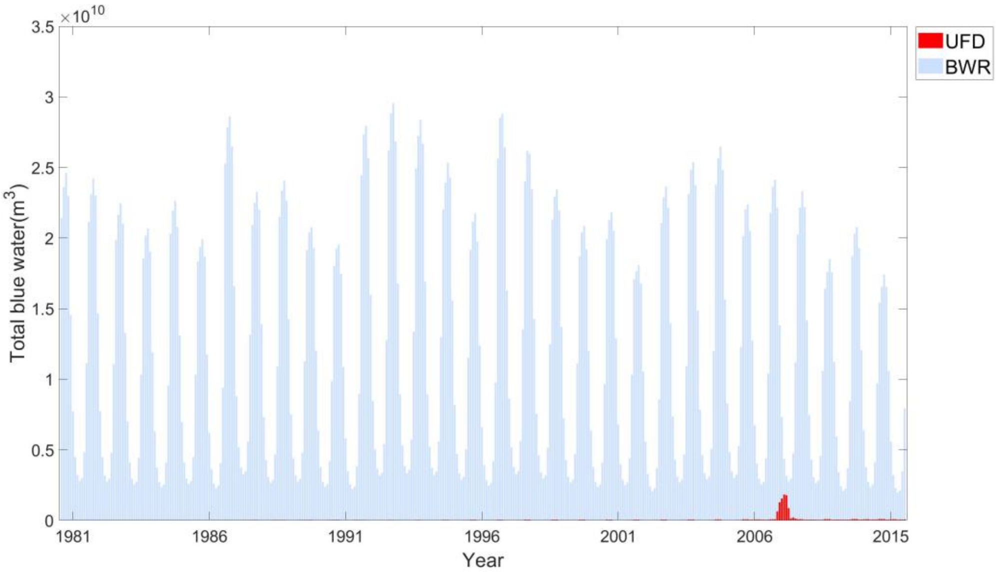
Scenarios formulating

B.1 UFD VS. BWR

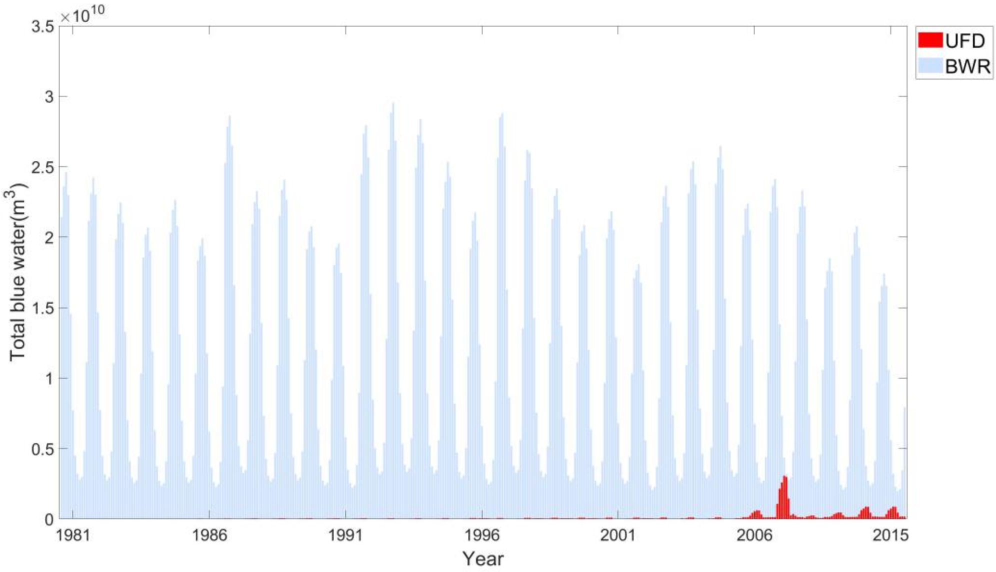
- 100%DFL



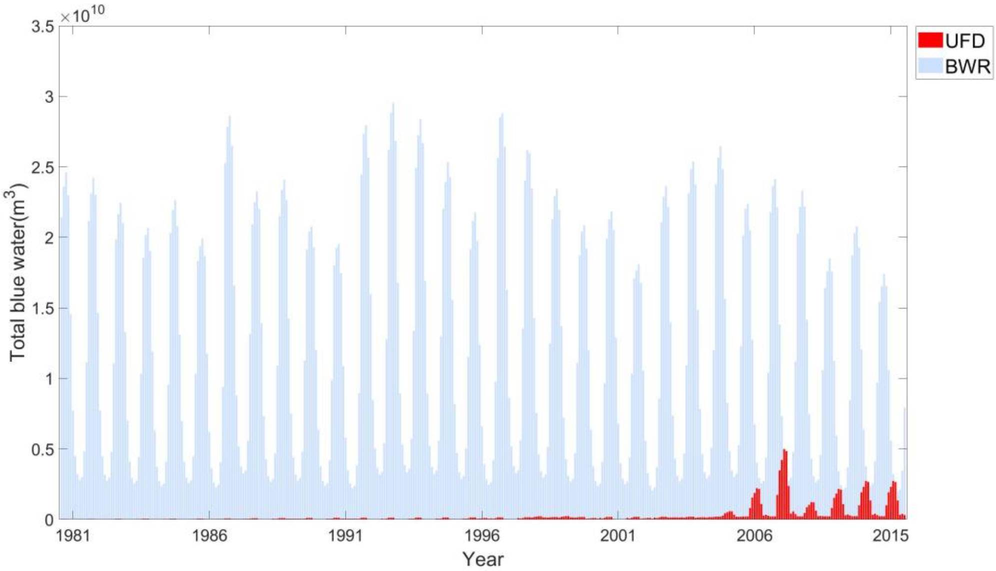
- 85%DFL



- 75%DFL


×10^10
3.5
3
2.5
2
1.5
1
0.5
0
Total blue water(m^3)
UFD
BWR
1981
1986
1991
1996
2001
2006
2015
Year

- 60%DFL


×10^10
3.5
3
2.5
2
1.5
1
0.5
0
Total blue water(m^3)
UFD
BWR
1981
1986
1991
1996
2001
2006
2015
Year

B.2 Monthly SWC and GWC

- Provinces (SWC):

Province	DFL [%]	Surface Water Cap											
		January	February	March	April	May	June	July	August	September	October	November	December
Ardebil	100% DFL	71.58	83.11	92.57	92.79	43.86	17.33	8.18	6.53	6.35	16.25	47.26	70.48
		49.89	56.13	61.26	56.46	29.23	9.03	3.40	2.18	2.12	5.57	31.69	49.29
		15.48	17.25	18.70	16.72	9.23	4.83	0.00	0.00	0.00	0.06	10.34	15.31
	85% DFL	71.58	83.11	92.57	92.79	43.86	17.33	8.18	6.53	6.35	16.25	47.26	70.48
		49.89	56.13	61.26	56.46	29.23	9.03	3.40	2.18	2.12	5.57	31.69	49.29
		15.48	17.25	18.70	16.72	9.23	4.83	0.00	0.00	0.00	0.06	10.34	15.31
	75% DFL	71.58	83.11	92.57	92.79	43.86	17.33	8.18	6.53	6.35	16.25	47.26	70.48
		49.89	56.13	61.26	56.46	29.23	9.03	3.40	2.18	2.12	5.57	31.69	49.29
		15.48	17.25	18.70	16.72	9.23	4.83	0.00	0.00	0.00	0.06	10.34	15.31
	60% DFL	71.58	83.11	92.57	92.79	43.86	17.33	8.18	6.53	6.35	16.25	47.26	70.48
		49.89	56.13	61.26	56.46	29.23	9.03	3.40	2.18	2.12	5.57	31.69	49.29
		15.48	17.25	18.70	16.72	9.23	4.83	0.00	0.00	0.00	0.06	10.34	15.31
WestAzarbaijan	100% DFL	87.13	106.38	447.82	894.71	356.80	125.94	60.83	32.27	28.51	39.00	93.60	101.27
		47.28	70.05	288.05	510.25	218.59	78.62	25.10	13.05	10.23	15.49	54.94	64.00
		24.27	29.63	87.06	147.32	64.91	29.55	3.51	0.00	0.00	0.00	26.07	28.21
	85% DFL	87.13	106.38	447.82	894.71	356.80	125.94	60.83	32.27	28.51	39.00	93.60	101.27
		47.28	70.05	288.05	510.25	218.59	78.62	25.10	13.05	10.23	15.49	54.94	64.00
		24.27	29.63	87.06	147.32	64.91	29.55	3.51	0.00	0.00	0.00	26.07	28.21
	75% DFL	87.13	106.38	447.82	894.71	356.80	125.94	60.83	32.27	28.51	39.00	93.60	101.27
		47.28	70.05	288.05	510.25	218.59	78.62	25.10	13.05	10.23	15.49	54.94	64.00
		24.27	29.63	87.06	147.32	64.91	29.55	3.51	0.00	0.00	0.00	26.07	28.21
	60% DFL	87.13	106.38	447.82	894.71	356.80	125.94	60.83	32.27	28.51	39.00	93.60	101.27
		47.28	70.05	288.05	510.25	218.59	78.62	25.10	13.05	10.23	15.49	54.94	64.00
		24.27	29.63	87.06	147.32	64.91	29.55	3.51	0.00	0.00	0.00	26.07	28.21
EastAzarbaijan	100% DFL	35.46	57.27	198.90	295.19	139.83	49.44	23.29	12.54	11.31	14.11	31.57	37.78
		21.92	35.53	128.97	174.83	88.04	32.14	10.53	5.32	4.27	5.00	17.20	24.73
		12.89	16.36	48.89	64.10	33.03	14.95	1.86	0.00	0.00	0.00	11.48	13.74
	85% DFL	35.46	57.27	198.90	295.19	139.83	49.44	23.29	12.54	11.31	14.11	31.57	37.78
		21.92	35.53	128.97	174.83	88.04	32.14	10.53	5.32	4.27	5.00	17.20	24.73
		12.89	16.36	48.89	64.10	33.03	14.95	1.86	0.00	0.00	0.00	11.48	13.74
	75% DFL	35.46	57.27	198.90	295.19	139.83	49.44	23.29	12.54	11.31	14.11	31.57	37.78
		21.92	35.53	128.97	174.83	88.04	32.14	10.53	5.32	4.27	5.00	17.20	24.73
		12.89	16.36	48.89	64.10	33.03	14.95	1.86	0.00	0.00	0.00	11.48	13.74
	60% DFL	35.46	57.27	198.90	295.19	139.83	49.44	23.29	12.54	11.31	14.11	31.57	37.78
		21.92	35.53	128.97	174.83	88.04	32.14	10.53	5.32	4.27	5.00	17.20	24.73
		12.89	16.36	48.89	64.10	33.03	14.95	1.86	0.00	0.00	0.00	11.48	13.74
Bushehr	100% DFL	90.05	78.88	34.63	21.79	4.35	2.59	2.08	1.84	1.69	1.65	2.70	53.88
		56.01	49.77	25.04	15.01	2.00	0.86	0.69	0.61	0.56	0.55	0.90	35.80
		20.92	18.68	9.83	5.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.68
	85% DFL	90.05	78.88	34.63	21.79	4.35	2.59	2.08	1.84	1.69	1.65	2.70	53.88
		56.01	49.77	25.04	15.01	2.00	0.86	0.69	0.61	0.56	0.55	0.90	35.80
		20.92	18.68	9.83	5.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.68
	75% DFL	90.05	78.88	34.63	21.79	4.35	2.59	2.08	1.84	1.69	1.65	2.70	53.88
		56.01	49.77	25.04	15.01	2.00	0.86	0.69	0.61	0.56	0.55	0.90	35.80
		20.92	18.68	9.83	5.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.68
	60% DFL	90.05	78.88	34.63	21.79	4.35	2.59	2.08	1.84	1.69	1.65	2.70	53.88
		56.01	49.77	25.04	15.01	2.00	0.86	0.69	0.61	0.56	0.55	0.90	35.80
		20.92	18.68	9.83	5.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.68
Chaharmahal	100% DFL	399.20	448.85	345.79	268.91	109.03	51.44	27.88	21.97	18.04	16.57	21.36	126.34
		251.58	278.50	222.62	165.32	68.36	24.45	12.24	7.82	6.01	5.52	7.12	78.61
		75.49	83.10	67.31	49.16	24.67	10.35	0.00	0.00	0.00	0.00	0.00	27.65
	85% DFL	399.20	448.85	345.79	268.91	109.03	51.44	27.88	21.97	18.04	16.57	21.36	126.34
		251.58	278.50	222.62	165.32	68.36	24.45	12.24	7.82	6.01	5.52	7.12	78.61
		75.49	83.10	67.31	49.16	24.67	10.35	0.00	0.00	0.00	0.00	0.00	27.65
	75% DFL	399.20	448.85	345.79	268.91	109.03	51.44	27.88	21.97	18.04	16.57	21.36	126.34
		251.58	278.50	222.62	165.32	68.36	24.45	12.24	7.82	6.01	5.52	7.12	78.61
		75.49	83.10	67.31	49.16	24.67	10.35	0.00	0.00	0.00	0.00	0.00	27.65
	60% DFL	399.20	448.85	345.79	268.91	109.03	51.44	27.88	21.97	18.04	16.57	21.36	126.34
		251.58	278.50	222.62	165.32	68.36	24.45	12.24	7.82	6.01	5.52	7.12	78.61
		75.49	83.10	67.31	49.16	24.67	10.35	0.00	0.00	0.00	0.00	0.00	27.65
Esfahan	100% DFL	167.71	336.25	365.59	313.29	127.87	55.79	43.52	27.58	25.07	25.35	44.14	105.53
		119.77	220.95	237.35	193.41	88.11	34.82	19.94	13.57	11.43	8.92	15.13	65.23
		47.92	84.14	90.01	72.04	34.96	20.29	4.07	0.00	0.00	0.00	0.00	30.15
	85% DFL	167.71	336.25	365.59	313.29	127.87	55.79	43.52	27.58	25.07	25.35	44.14	105.53
		119.77	220.95	237.35	193.41	88.11	34.82	19.94	13.57	11.43	8.92	15.13	65.23
		47.92	84.14	90.01	72.04	34.96	20.29	4.07	0.00	0.00	0.00	0.00	30.15
	75% DFL	167.71	336.25	365.59	313.29	127.87	55.79	43.52	27.58	25.07	25.35	44.14	105.53
		119.77	220.95	237.35	193.41	88.11	34.82	19.94	13.57	11.43	8.92	15.13	65.23
		47.92	84.14	90.01	72.04	34.96	20.29	4.07	0.00	0.00	0.00	0.00	30.15
	60% DFL	167.71	336.25	365.59	313.29	127.87	55.79	43.52	27.58	25.07	25.35	44.14	105.53
		119.77	220.95	237.35	193.41	88.11	34.82	19.94	13.57	11.43	8.92	15.13	65.23
		47.92	84.14	90.01	72.04	34.96	20.29	4.07	0.00	0.00	0.00	0.00	30.15
Fars	100% DFL	390.79	522.58	279.98	161.97	43.81	18.56	14.35	12.22	10.89	10.31	13.26	167.54
		250.10	323.72	188.19	108.14	21.60	6.42	4.78	4.07	3.63	3.44	4.42	120.20
		94.37	120.73	72.21	41.40	7.60	0.00	0.00	0.00	0.00	0.00	0.00	47.87
	85% DFL	390.79	522.58	279.98	161.97	43.81	18.56	14.35	12.22	10.89	10.31	13.26	167.54
		250.10	323.72	188.19	108.14	21.60	6.42	4.78	4.07	3.63	3.44	4.42	120.20
		94.37	120.73	72.21	41.40	7.60	0.00	0.00	0.00	0.00	0.00	0.00	47.87
	75% DFL	390.79	522.58	279.98	161.97	43.81	18.56	14.35	12.22	10.89	10.31	13.26	167.54
		250.10	323.72	188.19	108.14	21.60	6.42	4.78	4.07	3.63	3.44	4.42	120.20
		94.37	120.73	72.21	41.40	7.60	0.00	0.00	0.00	0.00	0.00	0.00	47.87
	60% DFL	390.79	522.58	279.98	161.97	43.81	18.56	14.35	12.22	10.89	10.31	13.26	167.54
		250.10	323.72	188.19	108.14	21.60	6.42	4.78	4.07	3.63	3.44	4.42	120.20
		94.37	120.73	72.21	41.40	7.60	0.00	0.00	0.00	0.00	0.00	0.00	47.87
Qazvin	100% DFL	33.40	42.68	104.02	106.93	52.38	21.72	12.81	7.50	6.88	11.06	15.19	21.93
		21.80	29.31	64.86	62.67	33.10	13.51	6.39	4.02	3.07	3.05	7.54	15.51
		7.31	9.34	19.39	18.30	9.94	5.24	3.26	0.00	0.00	0.00	4.23	6.11
	85% DFL	33.40	42.68	104.02	106.93	52.38	21.72	12.81	7.50	6.88	11.06	15.19	21.93
		21.80	29.31	64.86	62.67	33.10	13.51	6.39	4.02	3.07	3.05	7.54	15.51
		7.31	9.34	19.39	18.30	9.94	5.24	3.26	0.00	0.00	0.00	4.23	6.11
	75% DFL	33.40	42.68	104.02	106.93	52.38	21.72	12.81	7.50	6.88	11.06	15.19	21.93
		21.80	29.31	64.86	62.67	33.10	13.51	6.39	4.02	3.07	3.05	7.54	15.51
		7.31	9.34	19.39	18.30	9.94	5.24	3.26	0.00	0.00	0.00	4.23	6.11

	60% DFL	33.40	42.68	104.02	106.93	52.38	21.72	12.81	7.50	6.88	11.06	15.19	21.93
		21.80	29.31	64.86	62.67	33.10	13.51	6.39	4.02	3.07	3.05	7.54	15.51
		7.31	9.34	19.39	18.30	9.94	5.24	3.26	0.00	0.00	0.00	4.23	6.11
Qom	100% DFL	2.16	3.05	7.91	6.54	2.95	1.70	1.96	1.21	0.85	0.80	0.98	1.36
		1.38	2.17	5.05	4.01	2.00	1.11	1.28	0.78	0.40	0.25	0.44	0.90
		0.62	0.87	1.91	1.49	0.77	0.52	0.57	0.42	0.11	0.00	0.16	0.49
	85% DFL	2.16	3.05	7.91	6.54	2.95	1.70	1.96	1.21	0.85	0.80	0.98	1.36
		1.38	2.17	5.05	4.01	2.00	1.11	1.28	0.78	0.40	0.25	0.44	0.90
		0.62	0.87	1.91	1.49	0.77	0.52	0.57	0.42	0.11	0.00	0.16	0.49
	75% DFL	2.16	3.05	7.91	6.54	2.95	1.70	1.96	1.21	0.85	0.80	0.98	1.36
		1.38	2.17	5.05	4.01	2.00	1.11	1.28	0.78	0.40	0.25	0.44	0.90
		0.62	0.87	1.91	1.49	0.77	0.52	0.57	0.42	0.11	0.00	0.16	0.49
	60% DFL	2.16	3.05	7.91	6.54	2.95	1.70	1.96	1.21	0.85	0.80	0.98	1.36
		1.38	2.17	5.05	4.01	2.00	1.11	1.28	0.78	0.40	0.25	0.44	0.90
		0.62	0.87	1.91	1.49	0.77	0.52	0.57	0.42	0.11	0.00	0.16	0.49
Gilan	100% DFL	260.66	278.26	215.53	211.01	108.38	44.03	21.12	16.47	16.25	24.58	66.14	179.05
		167.94	177.37	143.75	128.77	71.22	21.81	8.75	5.49	5.42	9.38	42.05	124.20
		38.90	40.93	33.69	29.25	17.41	9.23	0.00	0.00	0.00	0.00	13.87	29.48
	85% DFL	260.66	278.26	215.53	211.01	108.38	44.03	21.12	16.47	16.25	24.58	66.14	179.05
		167.94	177.37	143.75	128.77	71.22	21.81	8.75	5.49	5.42	9.38	42.05	124.20
		38.90	40.93	33.69	29.25	17.41	9.23	0.00	0.00	0.00	0.00	13.87	29.48
	75% DFL	260.66	278.26	215.53	211.01	108.38	44.03	21.12	16.47	16.25	24.58	66.14	179.05
		167.94	177.37	143.75	128.77	71.22	21.81	8.75	5.49	5.42	9.38	42.05	124.20
		38.90	40.93	33.69	29.25	17.41	9.23	0.00	0.00	0.00	0.00	13.87	29.48
	60% DFL	260.66	278.26	215.53	211.01	108.38	44.03	21.12	16.47	16.25	24.58	66.14	179.05
		167.94	177.37	143.75	128.77	71.22	21.81	8.75	5.49	5.42	9.38	42.05	124.20
		38.90	40.93	33.69	29.25	17.41	9.23	0.00	0.00	0.00	0.00	13.87	29.48
Gorgan	100% DFL	23.06	31.49	38.60	28.99	13.51	5.77	3.77	2.32	2.90	8.49	18.79	24.05
		16.43	21.61	25.54	18.36	9.04	2.73	2.17	0.77	1.17	5.20	13.04	17.21
		6.59	8.46	9.88	7.00	3.86	0.86	0.00	0.00	0.00	3.09	5.37	6.87
	85% DFL	23.06	31.49	38.60	28.99	13.51	5.77	3.77	2.32	2.90	8.49	18.79	24.05
		16.43	21.61	25.54	18.36	9.04	2.73	2.17	0.77	1.17	5.20	13.04	17.21
		6.59	8.46	9.88	7.00	3.86	0.86	0.00	0.00	0.00	3.09	5.37	6.87
	75% DFL	23.06	31.49	38.60	28.99	13.51	5.77	3.77	2.32	2.90	8.49	18.79	24.05
		16.43	21.61	25.54	18.36	9.04	2.73	2.17	0.77	1.17	5.20	13.04	17.21
		6.59	8.46	9.88	7.00	3.86	0.86	0.00	0.00	0.00	3.09	5.37	6.87
	60% DFL	23.06	31.49	38.60	28.99	13.51	5.77	3.77	2.32	2.90	8.49	18.79	24.05
		16.43	21.61	25.54	18.36	9.04	2.73	2.17	0.77	1.17	5.20	13.04	17.21
		6.59	8.46	9.88	7.00	3.86	0.86	0.00	0.00	0.00	3.09	5.37	6.87
Hamedan	100% DFL	8.18	10.15	27.53	31.47	15.87	6.61	3.70	2.12	1.95	3.24	4.42	5.82
		5.01	6.83	17.26	18.36	9.90	4.13	1.96	1.15	0.89	1.01	2.35	4.01
		1.79	2.22	5.17	5.35	2.96	1.54	1.03	0.00	0.00	0.00	1.23	1.62
	85% DFL	8.18	10.15	27.53	31.47	15.87	6.61	3.70	2.12	1.95	3.24	4.42	5.82
		5.01	6.83	17.26	18.36	9.90	4.13	1.96	1.15	0.89	1.01	2.35	4.01
		1.79	2.22	5.17	5.35	2.96	1.54	1.03	0.00	0.00	0.00	1.23	1.62
	75% DFL	8.18	10.15	27.53	31.47	15.87	6.61	3.70	2.12	1.95	3.24	4.42	5.82
		5.01	6.83	17.26	18.36	9.90	4.13	1.96	1.15	0.89	1.01	2.35	4.01
		1.79	2.22	5.17	5.35	2.96	1.54	1.03	0.00	0.00	0.00	1.23	1.62
	60% DFL	8.18	10.15	27.53	31.47	15.87	6.61	3.70	2.12	1.95	3.24	4.42	5.82
		5.01	6.83	17.26	18.36	9.90	4.13	1.96	1.15	0.89	1.01	2.35	4.01
		1.79	2.22	5.17	5.35	2.96	1.54	1.03	0.00	0.00	0.00	1.23	1.62
Hormozgan	100% DFL	131.27	157.91	119.52	32.06	8.26	5.79	4.76	4.07	3.63	3.38	3.53	39.48
		83.18	98.06	76.62	21.92	4.08	2.02	1.59	1.36	1.21	1.13	1.18	27.32
		31.28	36.61	28.93	9.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.28
	85% DFL	131.27	157.91	119.52	32.06	8.26	5.79	4.76	4.07	3.63	3.38	3.53	39.48
		83.18	98.06	76.62	21.92	4.08	2.02	1.59	1.36	1.21	1.13	1.18	27.32
		31.28	36.61	28.93	9.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.28
	75% DFL	131.27	157.91	119.52	32.06	8.26	5.79	4.76	4.07	3.63	3.38	3.53	39.48
		83.18	98.06	76.62	21.92	4.08	2.02	1.59	1.36	1.21	1.13	1.18	27.32
		31.28	36.61	28.93	9.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.28
	60% DFL	131.27	157.91	119.52	32.06	8.26	5.79	4.76	4.07	3.63	3.38	3.53	39.48
		83.18	98.06	76.62	21.92	4.08	2.02	1.59	1.36	1.21	1.13	1.18	27.32
		31.28	36.61	28.93	9.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.28
Ilam	100% DFL	101.65	121.67	170.09	225.07	165.12	72.74	25.85	11.38	9.07	8.80	14.63	43.26
		70.51	84.50	110.76	132.33	99.83	48.47	11.38	3.97	3.02	2.93	4.88	28.31
		22.25	26.20	33.62	38.68	29.50	15.34	3.12	0.00	0.00	0.00	0.00	12.05
	85% DFL	101.65	121.67	170.09	225.07	165.12	72.74	25.85	11.38	9.07	8.80	14.63	43.26
		70.51	84.50	110.76	132.33	99.83	48.47	11.38	3.97	3.02	2.93	4.88	28.31
		22.25	26.20	33.62	38.68	29.50	15.34	3.12	0.00	0.00	0.00	0.00	12.05
	75% DFL	101.65	121.67	170.09	225.07	165.12	72.74	25.85	11.38	9.07	8.80	14.63	43.26
		70.51	84.50	110.76	132.33	99.83	48.47	11.38	3.97	3.02	2.93	4.88	28.31
		22.25	26.20	33.62	38.68	29.50	15.34	3.12	0.00	0.00	0.00	0.00	12.05
	60% DFL	101.65	121.67	170.09	225.07	165.12	72.74	25.85	11.38	9.07	8.80	14.63	43.26
		70.51	84.50	110.76	132.33	99.83	48.47	11.38	3.97	3.02	2.93	4.88	28.31
		22.25	26.20	33.62	38.68	29.50	15.34	3.12	0.00	0.00	0.00	0.00	12.05
Kerman	100% DFL	152.87	289.50	250.43	99.21	32.15	16.75	14.40	12.70	11.57	10.86	10.99	39.08
		104.25	180.53	158.72	65.89	20.21	8.59	6.58	5.13	4.21	3.62	3.66	25.04
		40.22	67.55	59.73	25.20	11.69	0.00	0.00	0.00	0.00	0.00	0.00	14.21
	85% DFL	152.87	289.50	250.43	99.21	32.15	16.75	14.40	12.70	11.57	10.86	10.99	39.08
		104.25	180.53	158.72	65.89	20.21	8.59	6.58	5.13	4.21	3.62	3.66	25.04
		40.22	67.55	59.73	25.20	11.69	0.00	0.00	0.00	0.00	0.00	0.00	14.21
	75% DFL	152.87	289.50	250.43	99.21	32.15	16.75	14.40	12.70	11.57	10.86	10.99	39.08
		104.25	180.53	158.72	65.89	20.21	8.59	6.58	5.13	4.21	3.62	3.66	25.04
		40.22	67.55	59.73	25.20	11.69	0.00	0.00	0.00	0.00	0.00	0.00	14.21
	60% DFL	152.87	289.50	250.43	99.21	32.15	16.75	14.40	12.70	11.57	10.86	10.99	39.08
		104.25	180.53	158.72	65.89	20.21	8.59	6.58	5.13	4.21	3.62	3.66	25.04
		40.22	67.55	59.73	25.20	11.69	0.00	0.00	0.00	0.00	0.00	0.00	14.21
Kermanshah	100% DFL	31.88	32.09	113.40	190.65	104.51	42.12	20.41	10.64	10.13	19.64	27.69	42.64
		22.23	22.48	74.04	110.35	63.64	27.64	11.14	5.57	4.50	7.75	17.27	25.67
		8.88	8.94	22.49	32.05	18.86	9.22	5.69	0.00	0.00	2.28	7.71	9.33
	85% DFL	31.88	32.09	113.40	190.65	104.51	42.12	20.41	10.64	10.13	19.64	27.69	42.64
		22.23	22.48	74.04	110.35	63.64	27.64	11.14	5.57	4.50	7.75	17.27	25.67
		8.88	8.94	22.49	32.05	18.86	9.22	5.69	0.00	0.00	2.28	7.71	9.33
	75% DFL	31.88	32.09	113.40	190.65	104.51	42.12	20.41	10.64	10.13	19.64	27.69	42.64
		22.23	22.48	74.04	110.35	63.64	27.64	11.14	5.57	4.50	7.75	17.27	25.67
		8.88	8.94	22.49	32.05	18.86	9.22	5.69	0.00	0.00	2.28	7.71	9.33
	60% DFL	31.88	32.09	113.40	190.65	104.51	42.12	20.41	10.64	10.13	19.64	27.69	42.64
		22.23	22.48	74.04	110.35	63.64	27.64	11.14	5.57	4.50	7.75	17.27	25.67
		8.88	8.94	22.49	32.05	18.86	9.22	5.69	0.00	0.00	2.28	7.71	9.33
Khuzestan	100% DFL	289.45	182.68	148.86	288.08	139.33	38.11	19.59	16.45	14.50	13.98	59.78	164.31
		189.76	130.12	106.88	176.53	93.43	18.38	8.26	5.71	4.83	4.66	39.35	119.21
		72.21	50.85	42.53	65.57	35.82	5.67	0.00	0.00	0.00	0.00	21.74	46.95

	85% DFL	289.45	182.68	148.86	288.08	139.33	38.11	19.59	16.45	14.50	13.98	59.78	164.31
		189.76	130.12	106.88	176.53	93.43	18.38	8.26	5.71	4.83	4.66	39.35	119.21
		72.21	50.85	42.53	65.57	35.82	5.67	0.00	0.00	0.00	0.00	21.74	46.95
	75% DFL	289.45	182.68	148.86	288.08	139.33	38.11	19.59	16.45	14.50	13.98	59.78	164.31
		189.76	130.12	106.88	176.53	93.43	18.38	8.26	5.71	4.83	4.66	39.35	119.21
		72.21	50.85	42.53	65.57	35.82	5.67	0.00	0.00	0.00	0.00	21.74	46.95
	60% DFL	289.45	182.68	148.86	288.08	139.33	38.11	19.59	16.45	14.50	13.98	59.78	164.31
		189.76	130.12	106.88	176.53	93.43	18.38	8.26	5.71	4.83	4.66	39.35	119.21
		72.21	50.85	42.53	65.57	35.82	5.67	0.00	0.00	0.00	0.00	21.74	46.95
Kohgiluieh	100% DFL	480.66	472.42	310.16	203.94	65.81	26.14	19.13	14.96	12.17	11.14	19.77	195.23
		295.08	290.61	202.63	129.72	40.29	11.11	6.38	4.99	4.06	3.71	6.59	135.92
		87.69	86.43	61.58	39.05	17.89	0.00	0.00	0.00	0.00	0.00	0.00	42.73
	85% DFL	480.66	472.42	310.16	203.94	65.81	26.14	19.13	14.96	12.17	11.14	19.77	195.23
		295.08	290.61	202.63	129.72	40.29	11.11	6.38	4.99	4.06	3.71	6.59	135.92
		87.69	86.43	61.58	39.05	17.89	0.00	0.00	0.00	0.00	0.00	0.00	42.73
	75% DFL	480.66	472.42	310.16	203.94	65.81	26.14	19.13	14.96	12.17	11.14	19.77	195.23
		295.08	290.61	202.63	129.72	40.29	11.11	6.38	4.99	4.06	3.71	6.59	135.92
		87.69	86.43	61.58	39.05	17.89	0.00	0.00	0.00	0.00	0.00	0.00	42.73
	60% DFL	480.66	472.42	310.16	203.94	65.81	26.14	19.13	14.96	12.17	11.14	19.77	195.23
		295.08	290.61	202.63	129.72	40.29	11.11	6.38	4.99	4.06	3.71	6.59	135.92
		87.69	86.43	61.58	39.05	17.89	0.00	0.00	0.00	0.00	0.00	0.00	42.73
Kordestan	100% DFL	72.13	77.49	294.73	474.96	248.84	95.78	46.49	24.45	22.95	43.16	63.05	76.07
		48.27	54.60	189.86	274.22	151.62	60.11	23.87	10.93	9.80	14.26	37.52	52.93
		20.09	21.58	57.41	79.57	44.93	21.48	12.95	0.00	0.00	0.00	17.56	21.19
	85% DFL	72.13	77.49	294.73	474.96	248.84	95.78	46.49	24.45	22.95	43.16	63.05	76.07
		48.27	54.60	189.86	274.22	151.62	60.11	23.87	10.93	9.80	14.26	37.52	52.93
		20.09	21.58	57.41	79.57	44.93	21.48	12.95	0.00	0.00	0.00	17.56	21.19
	75% DFL	72.13	77.49	294.73	474.96	248.84	95.78	46.49	24.45	22.95	43.16	63.05	76.07
		48.27	54.60	189.86	274.22	151.62	60.11	23.87	10.93	9.80	14.26	37.52	52.93
		20.09	21.58	57.41	79.57	44.93	21.48	12.95	0.00	0.00	0.00	17.56	21.19
	60% DFL	72.13	77.49	294.73	474.96	248.84	95.78	46.49	24.45	22.95	43.16	63.05	76.07
		48.27	54.60	189.86	274.22	151.62	60.11	23.87	10.93	9.80	14.26	37.52	52.93
		20.09	21.58	57.41	79.57	44.93	21.48	12.95	0.00	0.00	0.00	17.56	21.19
Lorestan	100% DFL	100.21	143.81	384.54	315.61	142.16	63.19	41.15	35.30	23.02	23.67	42.46	61.91
		63.92	99.59	235.09	185.90	91.85	39.16	21.14	14.21	12.18	9.40	17.44	40.45
		21.93	31.47	69.76	54.38	27.80	15.71	11.46	1.23	0.00	0.00	6.39	17.25
	85% DFL	100.21	143.81	384.54	315.61	142.16	63.19	41.15	35.30	23.02	23.67	42.46	61.91
		63.92	99.59	235.09	185.90	91.85	39.16	21.14	14.21	12.18	9.40	17.44	40.45
		21.93	31.47	69.76	54.38	27.80	15.71	11.46	1.23	0.00	0.00	6.39	17.25
	75% DFL	100.21	143.81	384.54	315.61	142.16	63.19	41.15	35.30	23.02	23.67	42.46	61.91
		63.92	99.59	235.09	185.90	91.85	39.16	21.14	14.21	12.18	9.40	17.44	40.45
		21.93	31.47	69.76	54.38	27.80	15.71	11.46	1.23	0.00	0.00	6.39	17.25
	60% DFL	100.21	143.81	384.54	315.61	142.16	63.19	41.15	35.30	23.02	23.67	42.46	61.91
		63.92	99.59	235.09	185.90	91.85	39.16	21.14	14.21	12.18	9.40	17.44	40.45
		21.93	31.47	69.76	54.38	27.80	15.71	11.46	1.23	0.00	0.00	6.39	17.25
Markazi	100% DFL	14.39	20.23	51.63	42.88	19.29	12.49	17.04	10.29	6.23	5.70	6.73	9.18
		8.76	13.82	32.16	25.56	12.77	7.82	11.36	6.39	3.06	1.73	2.83	5.72
		3.15	4.43	9.61	7.51	3.90	2.86	3.55	2.52	1.48	0.00	1.16	2.56
	85% DFL	14.39	20.23	51.63	42.88	19.29	12.49	17.04	10.29	6.23	5.70	6.73	9.18
		8.76	13.82	32.16	25.56	12.77	7.82	11.36	6.39	3.06	1.73	2.83	5.72
		3.15	4.43	9.61	7.51	3.90	2.86	3.55	2.52	1.48	0.00	1.16	2.56
	75% DFL	14.39	20.23	51.63	42.88	19.29	12.49	17.04	10.29	6.23	5.70	6.73	9.18
		8.76	13.82	32.16	25.56	12.77	7.82	11.36	6.39	3.06	1.73	2.83	5.72
		3.15	4.43	9.61	7.51	3.90	2.86	3.55	2.52	1.48	0.00	1.16	2.56
	60% DFL	14.39	20.23	51.63	42.88	19.29	12.49	17.04	10.29	6.23	5.70	6.73	9.18
		8.76	13.82	32.16	25.56	12.77	7.82	11.36	6.39	3.06	1.73	2.83	5.72
		3.15	4.43	9.61	7.51	3.90	2.86	3.55	2.52	1.48	0.00	1.16	2.56
Mazandaran	100% DFL	176.67	191.24	221.34	200.61	82.80	34.75	18.42	14.13	16.96	52.54	115.17	164.83
		120.10	127.91	144.04	121.63	51.21	13.92	7.44	4.71	6.34	29.66	76.69	113.76
		28.33	30.01	33.48	27.56	13.97	1.96	0.00	0.00	0.00	11.02	18.98	26.96
	85% DFL	176.67	191.24	221.34	200.61	82.80	34.75	18.42	14.13	16.96	52.54	115.17	164.83
		120.10	127.91	144.04	121.63	51.21	13.92	7.44	4.71	6.34	29.66	76.69	113.76
		28.33	30.01	33.48	27.56	13.97	1.96	0.00	0.00	0.00	11.02	18.98	26.96
	75% DFL	176.67	191.24	221.34	200.61	82.80	34.75	18.42	14.13	16.96	52.54	115.17	164.83
		120.10	127.91	144.04	121.63	51.21	13.92	7.44	4.71	6.34	29.66	76.69	113.76
		28.33	30.01	33.48	27.56	13.97	1.96	0.00	0.00	0.00	11.02	18.98	26.96
	60% DFL	176.67	191.24	221.34	200.61	82.80	34.75	18.42	14.13	16.96	52.54	115.17	164.83
		120.10	127.91	144.04	121.63	51.21	13.92	7.44	4.71	6.34	29.66	76.69	113.76
		28.33	30.01	33.48	27.56	13.97	1.96	0.00	0.00	0.00	11.02	18.98	26.96
NorthKhorasan	100% DFL	16.01	26.60	36.92	40.84	28.47	16.57	10.57	7.71	6.94	6.83	7.43	9.16
		10.63	19.26	25.03	25.26	18.35	11.41	6.85	4.93	4.05	3.09	3.81	5.91
		4.57	7.56	9.63	9.41	6.94	4.56	3.36	2.79	2.52	1.19	2.28	3.33
	85% DFL	16.01	26.60	36.92	40.84	28.47	16.57	10.57	7.71	6.94	6.83	7.43	9.16
		10.63	19.26	25.03	25.26	18.35	11.41	6.85	4.93	4.05	3.09	3.81	5.91
		4.57	7.56	9.63	9.41	6.94	4.56	3.36	2.79	2.52	1.19	2.28	3.33
	75% DFL	16.01	26.60	36.92	40.84	28.47	16.57	10.57	7.71	6.94	6.83	7.43	9.16
		10.63	19.26	25.03	25.26	18.35	11.41	6.85	4.93	4.05	3.09	3.81	5.91
		4.57	7.56	9.63	9.41	6.94	4.56	3.36	2.79	2.52	1.19	2.28	3.33
	60% DFL	16.01	26.60	36.92	40.84	28.47	16.57	10.57	7.71	6.94	6.83	7.43	9.16
		10.63	19.26	25.03	25.26	18.35	11.41	6.85	4.93	4.05	3.09	3.81	5.91
		4.57	7.56	9.63	9.41	6.94	4.56	3.36	2.79	2.52	1.19	2.28	3.33
RazaviKhorasan	100% DFL	40.99	85.90	91.30	78.93	44.78	26.78	19.00	15.46	14.06	13.52	14.05	19.39
		28.67	57.49	60.51	49.37	30.30	17.42	12.23	9.31	7.62	5.17	5.81	12.29
		11.71	22.03	23.11	18.48	11.65	8.05	6.50	5.62	4.00	0.33	1.29	7.05
	85% DFL	40.99	85.90	91.30	78.93	44.78	26.78	19.00	15.46	14.06	13.52	14.05	19.39
		28.67	57.49	60.51	49.37	30.30	17.42	12.23	9.31	7.62	5.17	5.81	12.29
		11.71	22.03	23.11	18.48	11.65	8.05	6.50	5.62	4.00	0.33	1.29	7.05
	75% DFL	40.99	85.90	91.30	78.93	44.78	26.78	19.00	15.46	14.06	13.52	14.05	19.39
		28.67	57.49	60.51	49.37	30.30	17.42	12.23	9.31	7.62	5.17	5.81	12.29
		11.71	22.03	23.11	18.48	11.65	8.05	6.50	5.62	4.00	0.33	1.29	7.05
	60% DFL	40.99	85.90	91.30	78.93	44.78	26.78	19.00	15.46	14.06	13.52	14.05	19.39
		28.67	57.49	60.51	49.37	30.30	17.42	12.23	9.31	7.62	5.17	5.81	12.29
		11.71	22.03	23.11	18.48	11.65	8.05	6.50	5.62	4.00	0.33	1.29	7.05
Semnan	100% DFL	8.07	11.62	19.54	20.73	13.39	7.02	4.38	3.15	2.85	3.29	4.13	6.78
		5.47	8.37	13.04	12.76	8.66	4.83	2.82	1.71	1.35	1.47	2.50	4.19
		2.31	3.32	4.99	4.75	3.28	2.01	1.48	0.90	0.36	0.55	1.50	1.94
	85% DFL	8.07	11.62	19.54	20.73	13.39	7.02	4.38	3.15	2.85	3.29	4.13	6.78
		5.47	8.37	13.04	12.76	8.66	4.83	2.82	1.71	1.35	1.47	2.50	4.19
		2.31	3.32	4.99	4.75	3.28	2.01	1.48	0.90	0.36	0.55	1.50	1.94
	75% DFL	8.07	11.62	19.54	20.73	13.39	7.02	4.38	3.15	2.85	3.29	4.13	6.78
		5.47	8.37	13.04	12.76	8.66	4.83	2.82	1.71	1.35	1.47	2.50	4.19
		2.31	3.32	4.99	4.75	3.28	2.01	1.48	0.90	0.36	0.55	1.50	1.94

	60% DFL	8.07	11.62	19.54	20.73	13.39	7.02	4.38	3.15	2.85	3.29	4.13	6.78
		5.47	8.37	13.04	12.76	8.66	4.83	2.82	1.71	1.35	1.47	2.50	4.19
		2.31	3.32	4.99	4.75	3.28	2.01	1.48	0.90	0.36	0.55	1.50	1.94
Sistan	100% DFL	156.72	190.04	190.90	61.25	20.23	10.96	10.19	8.63	7.93	7.53	7.71	32.08
		101.51	120.11	120.60	41.98	10.62	5.13	4.46	3.16	2.64	2.51	2.57	22.33
		38.50	45.16	45.33	16.22	5.00	0.00	0.00	0.00	0.00	0.00	0.00	11.67
	85% DFL	156.72	190.04	190.90	61.25	20.23	10.96	10.19	8.63	7.93	7.53	7.71	32.08
		101.51	120.11	120.60	41.98	10.62	5.13	4.46	3.16	2.64	2.51	2.57	22.33
		38.50	45.16	45.33	16.22	5.00	0.00	0.00	0.00	0.00	0.00	0.00	11.67
	75% DFL	156.72	190.04	190.90	61.25	20.23	10.96	10.19	8.63	7.93	7.53	7.71	32.08
		101.51	120.11	120.60	41.98	10.62	5.13	4.46	3.16	2.64	2.51	2.57	22.33
		38.50	45.16	45.33	16.22	5.00	0.00	0.00	0.00	0.00	0.00	0.00	11.67
	60% DFL	156.72	190.04	190.90	61.25	20.23	10.96	10.19	8.63	7.93	7.53	7.71	32.08
		101.51	120.11	120.60	41.98	10.62	5.13	4.46	3.16	2.64	2.51	2.57	22.33
		38.50	45.16	45.33	16.22	5.00	0.00	0.00	0.00	0.00	0.00	0.00	11.67
SouthKhorasan	100% DFL	17.13	37.75	34.04	19.65	8.46	5.32	4.56	4.11	3.76	2.54	2.43	4.80
		12.41	24.04	21.97	12.62	5.50	3.41	2.60	2.05	1.63	0.92	0.87	2.32
		4.89	9.06	8.32	4.77	2.53	1.90	1.59	0.77	0.13	0.00	0.00	1.18
	85% DFL	17.13	37.75	34.04	19.65	8.46	5.32	4.56	4.11	3.76	2.54	2.43	4.80
		12.41	24.04	21.97	12.62	5.50	3.41	2.60	2.05	1.63	0.92	0.87	2.32
		4.89	9.06	8.32	4.77	2.53	1.90	1.59	0.77	0.13	0.00	0.00	1.18
	75% DFL	17.13	37.75	34.04	19.65	8.46	5.32	4.56	4.11	3.76	2.54	2.43	4.80
		12.41	24.04	21.97	12.62	5.50	3.41	2.60	2.05	1.63	0.92	0.87	2.32
		4.89	9.06	8.32	4.77	2.53	1.90	1.59	0.77	0.13	0.00	0.00	1.18
	60% DFL	17.13	37.75	34.04	19.65	8.46	5.32	4.56	4.11	3.76	2.54	2.43	4.80
		12.41	24.04	21.97	12.62	5.50	3.41	2.60	2.05	1.63	0.92	0.87	2.32
		4.89	9.06	8.32	4.77	2.53	1.90	1.59	0.77	0.13	0.00	0.00	1.18
Tehran	100% DFL	24.76	33.91	86.69	81.75	39.77	17.97	10.79	8.80	5.80	8.95	11.66	16.12
		16.24	24.10	55.41	49.55	26.09	11.66	6.16	3.76	2.85	2.87	5.90	11.31
		7.07	9.69	20.90	18.33	9.93	5.57	3.80	0.19	0.00	0.00	3.41	5.86
	85% DFL	24.76	33.91	86.69	81.75	39.77	17.97	10.79	8.80	5.80	8.95	11.66	16.12
		16.24	24.10	55.41	49.55	26.09	11.66	6.16	3.76	2.85	2.87	5.90	11.31
		7.07	9.69	20.90	18.33	9.93	5.57	3.80	0.19	0.00	0.00	3.41	5.86
	75% DFL	24.76	33.91	86.69	81.75	39.77	17.97	10.79	8.80	5.80	8.95	11.66	16.12
		16.24	24.10	55.41	49.55	26.09	11.66	6.16	3.76	2.85	2.87	5.90	11.31
		7.07	9.69	20.90	18.33	9.93	5.57	3.80	0.19	0.00	0.00	3.41	5.86
	60% DFL	24.76	33.91	86.69	81.75	39.77	17.97	10.79	8.80	5.80	8.95	11.66	16.12
		16.24	24.10	55.41	49.55	26.09	11.66	6.16	3.76	2.85	2.87	5.90	11.31
		7.07	9.69	20.90	18.33	9.93	5.57	3.80	0.19	0.00	0.00	3.41	5.86
Yazd	100% DFL	28.17	64.36	58.22	44.74	20.13	10.71	8.31	7.28	4.84	4.70	7.06	11.82
		20.11	41.47	38.04	28.06	13.86	6.88	4.58	3.33	2.46	1.69	2.23	7.79
		8.05	15.70	14.47	10.52	5.60	3.71	2.56	0.68	0.00	0.00	0.00	4.30
	85% DFL	28.17	64.36	58.22	44.74	20.13	10.71	8.31	7.28	4.84	4.70	7.06	11.82
		20.11	41.47	38.04	28.06	13.86	6.88	4.58	3.33	2.46	1.69	2.23	7.79
		8.05	15.70	14.47	10.52	5.60	3.71	2.56	0.68	0.00	0.00	0.00	4.30
	75% DFL	28.17	64.36	58.22	44.74	20.13	10.71	8.31	7.28	4.84	4.70	7.06	11.82
		20.11	41.47	38.04	28.06	13.86	6.88	4.58	3.33	2.46	1.69	2.23	7.79
		8.05	15.70	14.47	10.52	5.60	3.71	2.56	0.68	0.00	0.00	0.00	4.30
	60% DFL	28.17	64.36	58.22	44.74	20.13	10.71	8.31	7.28	4.84	4.70	7.06	11.82
		20.11	41.47	38.04	28.06	13.86	6.88	4.58	3.33	2.46	1.69	2.23	7.79
		8.05	15.70	14.47	10.52	5.60	3.71	2.56	0.68	0.00	0.00	0.00	4.30
Zanjan	100% DFL	24.32	33.05	91.10	138.60	74.62	29.99	15.16	8.09	7.64	14.28	19.98	31.36
		17.20	20.32	58.78	80.36	45.67	18.82	8.22	4.27	3.42	5.32	12.06	18.69
		6.77	7.23	17.79	23.36	13.56	6.72	4.22	0.00	0.00	0.98	5.56	6.86
	85% DFL	24.32	33.05	91.10	138.60	74.62	29.99	15.16	8.09	7.64	14.28	19.98	31.36
		17.20	20.32	58.78	80.36	45.67	18.82	8.22	4.27	3.42	5.32	12.06	18.69
		6.77	7.23	17.79	23.36	13.56	6.72	4.22	0.00	0.00	0.98	5.56	6.86
	75% DFL	24.32	33.05	91.10	138.60	74.62	29.99	15.16	8.09	7.64	14.28	19.98	31.36
		17.20	20.32	58.78	80.36	45.67	18.82	8.22	4.27	3.42	5.32	12.06	18.69
		6.77	7.23	17.79	23.36	13.56	6.72	4.22	0.00	0.00	0.98	5.56	6.86
	60% DFL	24.32	33.05	91.10	138.60	74.62	29.99	15.16	8.09	7.64	14.28	19.98	31.36
		17.20	20.32	58.78	80.36	45.67	18.82	8.22	4.27	3.42	5.32	12.06	18.69
		6.77	7.23	17.79	23.36	13.56	6.72	4.22	0.00	0.00	0.98	5.56	6.86

- Provinces (GWC):

Province	Demand fulfilment [%]	Groundwater Cap											
		January	February	March	April	May	June	July	August	September	October	November	December
Ardebil	100% DFL	0.00	0.00	0.00	0.00	25.74	65.50	88.96	86.94	40.68	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	40.37	73.80	93.73	91.29	44.92	2.87	0.00	0.00
		0.00	0.00	0.00	19.67	60.37	78.00	97.14	93.47	47.03	8.38	1.98	0.00
	85% DFL	0.00	0.00	0.00	0.00	15.30	53.07	74.39	72.92	33.63	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	29.93	61.37	79.16	77.27	37.86	1.61	0.00	0.00
		0.00	0.00	0.00	14.21	49.93	65.58	82.57	79.45	39.98	7.12	0.13	0.00
	75% DFL	0.00	0.00	0.00	0.00	8.34	44.79	64.67	63.58	28.92	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	22.97	53.09	69.45	67.93	33.16	0.76	0.00	0.00
		0.00	0.00	0.00	10.57	42.97	57.29	72.85	70.10	35.27	6.27	0.00	0.00
	60% DFL	0.00	0.00	0.00	0.00	0.00	32.36	50.10	49.55	21.87	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	12.53	40.66	54.88	53.91	26.10	0.00	0.00	0.00
		0.00	0.00	0.00	5.11	32.53	44.87	58.28	56.08	28.22	5.01	0.00	0.00
WestAzarbaijan	100% DFL	0.00	0.00	0.00	0.00	0.00	38.42	131.82	153.12	65.05	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	85.74	167.55	172.35	83.34	1.75	0.00	0.00
		0.00	0.00	0.00	0.00	73.27	134.81	189.14	185.39	93.56	17.24	0.00	0.00
	85% DFL	0.00	0.00	0.00	0.00	0.00	13.76	102.92	125.31	51.02	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	61.08	138.66	144.54	69.30	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	52.54	110.15	160.24	157.59	79.53	14.65	0.00	0.00
	75% DFL	0.00	0.00	0.00	0.00	0.00	0.00	83.66	106.77	41.66	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	44.65	119.39	126.00	59.94	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	38.73	93.72	140.98	139.05	70.17	12.93	0.00	0.00
	60% DFL	0.00	0.00	0.00	0.00	0.00	0.00	54.76	78.96	27.63	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	20.00	90.49	98.19	45.91	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	18.00	69.06	112.08	111.24	56.14	10.34	0.00	0.00
EastAzarbaijan	100% DFL	0.00	0.00	0.00	0.00	70.56	205.54	279.00	280.54	131.05	8.61	0.90	0.00
		0.00	0.00	0.00	0.00	122.35	222.84	291.76	287.75	138.09	17.71	15.27	0.00
		0.00	0.00	0.00	40.17	177.36	240.03	300.43	293.07	142.36	22.72	21.00	6.91
	85% DFL	0.00	0.00	0.00	0.00	39.00	167.29	233.66	236.58	109.70	5.20	0.00	0.00
		0.00	0.00	0.00	0.00	90.79	184.59	246.41	243.79	116.74	14.31	10.40	0.00
		0.00	0.00	0.00	24.53	145.80	201.79	255.08	249.11	121.01	19.31	16.12	3.81

	75% DFL	0.00	0.00	0.00	0.00	17.96	141.79	203.43	207.27	95.46	2.93	0.00	0.00
		0.00	0.00	0.00	0.00	69.75	159.09	216.18	214.48	102.50	12.03	7.15	0.00
		0.00	0.00	0.00	14.11	124.77	176.29	224.86	219.81	106.77	17.04	12.88	1.75
	60% DFL	0.00	0.00	0.00	0.00	0.00	103.55	158.08	163.31	74.11	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	38.20	120.85	170.84	170.52	81.15	8.63	2.28	0.00
		0.00	0.00	0.00	0.00	93.21	138.04	179.51	175.84	85.42	13.63	8.01	0.00
Bushehr	100% DFL	0.00	0.00	0.00	7.92	55.06	69.31	83.06	80.72	38.68	5.23	6.91	0.00
		0.00	0.00	0.00	14.69	57.41	71.03	84.44	81.94	39.81	6.33	8.71	0.00
		0.00	0.00	0.00	23.73	59.41	71.89	85.13	82.55	40.37	6.88	9.61	0.00
	85% DFL	0.00	0.00	0.00	3.46	46.14	58.52	70.29	68.34	32.63	4.20	5.47	0.00
		0.00	0.00	0.00	10.24	48.50	60.25	71.67	69.56	33.75	5.30	7.27	0.00
		0.00	0.00	0.00	19.28	50.50	61.11	72.36	70.17	34.31	5.85	8.17	0.00
	75% DFL	0.00	0.00	0.00	0.49	40.20	51.33	61.77	60.08	28.59	3.51	4.51	0.00
		0.00	0.00	0.00	7.27	42.56	53.06	63.16	61.30	29.71	4.61	6.31	0.00
		0.00	0.00	0.00	16.31	44.56	53.92	63.85	61.92	30.28	5.16	7.21	0.00
	60% DFL	0.00	0.00	0.00	0.00	31.29	40.55	49.00	47.70	22.54	2.48	3.07	0.00
		0.00	0.00	0.00	2.81	33.65	42.27	50.39	48.92	23.66	3.58	4.87	0.00
		0.00	0.00	0.00	11.85	35.65	43.14	51.08	49.53	24.22	4.13	5.77	0.00
Chaharmahal	100% DFL	0.00	0.00	0.00	0.00	0.00	4.64	37.88	41.30	13.79	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	31.62	53.52	55.46	25.82	0.17	1.21	0.00
		0.00	0.00	0.00	0.00	22.45	45.72	65.76	63.28	31.83	5.70	8.33	0.00
	85% DFL	0.00	0.00	0.00	0.00	0.00	0.00	28.02	31.81	9.02	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	23.21	43.65	45.97	21.04	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	15.38	37.31	55.90	53.79	27.06	4.84	7.08	0.00
	75% DFL	0.00	0.00	0.00	0.00	0.00	0.00	21.44	25.48	5.84	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	17.60	37.08	39.64	17.86	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	10.67	31.70	49.32	47.46	23.87	4.27	6.25	0.00
	60% DFL	0.00	0.00	0.00	0.00	0.00	0.00	11.58	15.99	1.06	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	9.19	27.21	30.15	13.09	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	3.60	23.29	39.46	37.97	19.10	3.42	5.00	0.00
Esfahan	100% DFL	0.00	0.00	0.00	0.00	44.95	151.46	200.23	209.07	95.25	2.63	0.00	0.00
		0.00	0.00	0.00	0.00	84.71	172.43	223.81	223.07	108.89	19.05	20.37	0.00
		0.00	0.00	0.00	18.88	137.87	186.96	239.68	236.64	120.32	27.97	35.50	0.00
	85% DFL	0.00	0.00	0.00	0.00	19.03	120.37	163.67	173.57	77.20	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	58.79	141.34	187.25	187.58	90.84	14.86	15.04	0.00
		0.00	0.00	0.00	5.24	111.94	155.87	203.12	201.15	102.27	23.78	30.18	0.00
	75% DFL	0.00	0.00	0.00	0.00	1.75	99.64	139.29	149.91	65.17	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	41.51	120.62	162.87	163.91	78.81	12.06	11.49	0.00
		0.00	0.00	0.00	0.00	94.66	135.15	178.74	177.48	90.24	20.98	26.63	0.00
	60% DFL	0.00	0.00	0.00	0.00	0.00	68.56	102.73	114.41	47.12	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	15.58	89.53	126.31	128.42	60.76	7.86	6.17	0.00
		0.00	0.00	0.00	0.00	68.74	104.06	142.18	141.99	72.19	16.78	21.30	0.00
Fars	100% DFL	0.00	0.00	0.00	31.14	350.80	460.72	554.75	539.40	254.54	27.94	43.51	0.00
		0.00	0.00	0.00	84.97	373.00	472.87	564.32	547.54	261.80	34.81	52.35	0.00
		0.00	0.00	0.00	151.70	387.01	479.29	569.11	551.62	265.43	38.25	56.77	0.00
	85% DFL	0.00	0.00	0.00	2.17	291.61	388.83	469.39	456.66	214.72	22.20	35.00	0.00
		0.00	0.00	0.00	56.00	313.81	400.98	478.96	464.80	221.99	29.07	43.84	0.00
		0.00	0.00	0.00	122.74	327.82	407.39	483.74	468.87	225.62	32.51	48.26	0.00
	75% DFL	0.00	0.00	0.00	0.00	252.15	340.90	412.48	401.49	188.18	18.38	29.32	0.00
		0.00	0.00	0.00	36.69	274.35	353.05	422.04	409.64	195.44	25.25	38.16	0.00
		0.00	0.00	0.00	103.43	288.36	359.47	426.83	413.71	199.08	28.68	42.58	0.00
	60% DFL	0.00	0.00	0.00	0.00	192.96	269.01	327.11	318.75	148.37	12.64	20.80	0.00
		0.00	0.00	0.00	7.72	215.16	281.16	336.68	326.90	155.63	19.51	29.64	0.00
		0.00	0.00	0.00	74.46	229.17	287.57	341.46	330.97	159.26	22.95	34.06	0.00
Qazvin	100% DFL	0.00	0.00	0.00	0.00	9.59	51.06	71.68	73.99	36.64	0.91	0.00	0.00
		0.00	0.00	0.00	0.00	28.87	59.27	78.10	77.47	40.44	8.91	7.61	0.00
		0.68	0.00	0.00	16.52	52.03	67.54	81.22	81.48	43.52	11.96	10.91	5.18
	85% DFL	0.00	0.00	0.00	0.00	0.29	40.14	59.00	61.77	30.11	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	19.57	48.35	65.42	65.25	33.92	7.11	5.33	0.00
		0.00	0.00	0.00	11.30	42.73	56.62	68.55	69.26	36.99	10.17	8.64	3.49
	75% DFL	0.00	0.00	0.00	0.00	0.00	32.86	50.56	53.62	25.76	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	13.38	41.08	56.97	57.10	29.56	5.92	3.82	0.00
		0.00	0.00	0.00	7.82	36.53	49.34	60.10	61.11	32.64	8.97	7.13	2.36
	60% DFL	0.00	0.00	0.00	0.00	0.00	21.95	37.88	41.39	19.23	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	4.08	30.16	44.30	44.88	23.04	4.12	1.55	0.00
		0.00	0.00	0.00	2.59	27.24	38.43	47.43	48.89	26.11	7.18	4.85	0.67
Qom	100% DFL	0.30	0.00	0.00	6.21	21.45	27.59	32.52	32.26	16.08	3.00	3.89	2.21
		1.08	0.29	0.00	8.74	22.40	28.19	33.20	32.70	16.53	3.55	4.43	2.67
		1.84	1.59	0.55	11.26	23.63	28.77	33.91	33.05	16.82	3.80	4.71	3.08
	85% DFL	0.00	0.00	0.00	4.29	17.79	23.20	27.35	27.24	13.54	2.43	3.16	1.67
		0.71	0.00	0.00	6.83	18.74	23.79	28.03	27.68	13.99	2.98	3.70	2.13
		1.47	1.22	0.19	9.35	19.97	24.38	28.74	28.03	14.28	3.23	3.98	2.54
	75% DFL	0.00	0.00	0.00	3.02	15.35	20.27	23.90	23.90	11.85	2.05	2.67	1.32
		0.46	0.00	0.00	5.55	16.30	20.86	24.58	24.33	12.30	2.60	3.21	1.78
		1.23	0.97	0.00	8.07	17.53	21.45	25.29	24.68	12.59	2.85	3.49	2.18
	60% DFL	0.00	0.00	0.00	1.11	11.69	15.87	18.73	18.87	9.31	1.48	1.94	0.78
		0.09	0.00	0.00	3.64	12.64	16.47	19.41	19.31	9.76	2.03	2.48	1.24
		0.86	0.60	0.00	6.16	13.87	17.06	20.12	19.66	10.05	2.28	2.76	1.65
Gilan	100% DFL	0.00	0.00	0.00	0.00	0.00	11.01	45.48	50.01	15.42	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	33.22	57.84	60.99	26.25	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	26.10	45.80	66.60	66.48	31.67	8.21	0.00	0.00
	85% DFL	0.00	0.00	0.00	0.00	0.00	2.75	35.49	40.04	10.67	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	24.97	47.85	51.02	21.50	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	19.57	37.54	56.61	56.50	26.92	6.98	0.00	0.00
	75% DFL	0.00	0.00	0.00	0.00	0.00	0.00	28.83	33.39	7.50	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	19.46	41.19	44.37	18.34	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	15.22	32.04	49.95	49.86	23.75	6.16	0.00	0.00
	60% DFL	0.00	0.00	0.00	0.00	0.00	0.00	18.84	23.42	2.75	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	11.21	31.20	34.40	13.59	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	8.70	23.79	39.96	39.89	19.00	4.93	0.00	0.00
Gorgan	100% DFL	0.00	0.00	0.00	11.44	67.94	93.07	113.45	111.49	52.50	0.88	0.00	0.00
		0.00	0.00	0.00	22.06	72.41	96.11	115.05	113.04	54.23	4.16	0.00	0.00
		0.00	0.00	0.00	33.42	77.59	97.97	117.22	113.82	55.40	6.28	7.61	1.73
	85% DFL	0.00	0.00	0.00	5.37	55.72	78.25	95.87	94.42	44.19	0.00	0.00	0.00
		0.00	0.00	0.00	16.00	60.19	81.29	97.47	95.97	45.92	2.76	0.00	0.00
		0.00	0.00	0.00	27.36	65.37	83.15	99.64	96.74	47.09	4.87	5.66	0.44
	75% DFL	0.00	0.00	0.00	1.33	47.58	68.36	84.14	83.04	38.65	0.00	0.00	0.00
		0.00	0.00	0.00	11.96	52.05	71.40	85.74	84.59	40.38	1.82	0.00	0.00
		0.00	0.00	0.00	23.32	57.23	73.27	87.92	85.36	41.55	3.94	4.36	0.00
	60% DFL	0.00	0.00	0.00	0.00	35.36	53.54	66.56	65.97	30.34	0.00	0.00	0.00
		0.00	0.00	0.00	5.89	39.83	56.58	68.16	67.52	32.07	0.42	0.00	0.00
		0.00	0.00	0.00	17.25	45.01	58.44	70.33	68.29	33.24	2.53	2.42	0.00

Hamedan	100% DFL	0.00	0.00	0.00	24.65	92.13	122.06	147.33	143.18	70.79	9.20	14.10	5.34
		0.00	0.00	0.00	37.76	98.10	124.54	149.07	144.15	71.85	11.43	16.16	7.15
		3.06	2.63	0.00	50.77	105.04	127.13	150.00	145.29	72.74	12.44	17.28	9.53
	85% DFL	0.00	0.00	0.00	16.23	75.93	102.76	124.67	121.38	59.88	7.33	11.32	3.66
		0.00	0.00	0.00	29.34	81.90	105.24	126.41	122.35	60.94	9.56	13.39	5.47
		2.33	1.90	0.00	42.35	88.84	107.83	127.34	123.50	61.83	10.58	14.51	7.86
	75% DFL	0.00	0.00	0.00	10.62	65.13	89.89	109.57	106.85	52.60	6.09	9.47	2.55
		0.00	0.00	0.00	23.73	71.10	92.37	111.31	107.82	53.67	8.32	11.53	4.36
		1.85	1.42	0.00	36.74	78.04	94.96	112.24	108.97	54.56	9.33	12.66	6.75
	60% DFL	0.00	0.00	0.00	2.20	48.93	70.59	86.92	85.06	41.69	4.22	6.69	0.87
		0.00	0.00	0.00	15.31	54.90	73.07	88.66	86.03	42.76	6.45	8.76	2.69
		1.12	0.69	0.00	28.32	61.84	75.66	89.59	87.18	43.64	7.47	9.88	5.07
Hormozgan	100% DFL	0.00	0.00	0.00	9.28	75.17	95.32	115.11	112.14	52.81	5.61	9.33	0.00
		0.00	0.00	0.00	19.41	79.34	99.09	118.28	114.86	55.23	7.86	11.68	0.00
		0.00	0.00	0.00	32.17	83.42	101.11	119.87	116.22	56.44	8.99	12.86	0.00
	85% DFL	0.00	0.00	0.00	3.08	62.65	80.15	97.13	94.71	44.34	4.26	7.40	0.00
		0.00	0.00	0.00	13.21	66.83	83.93	100.30	97.43	46.76	6.51	9.75	0.00
		0.00	0.00	0.00	25.97	70.91	85.94	101.89	98.79	47.98	7.64	10.93	0.00
	75% DFL	0.00	0.00	0.00	0.00	54.31	70.04	85.14	83.09	38.70	3.37	6.12	0.00
		0.00	0.00	0.00	9.08	58.49	73.82	88.32	85.81	41.12	5.62	8.47	0.00
		0.00	0.00	0.00	21.84	62.57	75.83	89.90	87.16	42.33	6.74	9.64	0.00
	60% DFL	0.00	0.00	0.00	0.00	41.80	54.88	67.16	65.66	30.23	2.02	4.19	0.00
		0.00	0.00	0.00	2.88	45.97	58.65	70.33	68.37	32.65	4.27	6.54	0.00
		0.00	0.00	0.00	15.64	50.05	60.67	71.92	69.73	33.87	5.39	7.71	0.00
Ilam	100% DFL	0.00	0.00	0.00	0.00	0.00	0.00	30.18	42.50	17.69	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00	44.65	49.92	23.73	1.27	1.59	0.00
		0.00	0.00	0.00	0.00	10.44	32.32	52.91	53.89	26.75	4.20	6.47	0.00
	85% DFL	0.00	0.00	0.00	0.00	0.00	0.00	21.78	34.42	13.67	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00	36.25	41.84	19.72	0.64	0.62	0.00
		0.00	0.00	0.00	0.00	4.45	25.17	44.51	45.80	22.74	3.57	5.50	0.00
	75% DFL	0.00	0.00	0.00	0.00	0.00	0.00	16.18	29.03	11.00	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00	30.65	36.45	17.04	0.22	0.00	0.00
		0.00	0.00	0.00	0.00	0.46	20.41	38.90	40.41	20.06	3.15	4.85	0.00
	60% DFL	0.00	0.00	0.00	0.00	0.00	0.00	7.77	20.95	6.98	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00	22.24	28.36	13.03	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	13.26	30.50	32.33	16.05	2.52	3.88	0.00
Kerman	100% DFL	0.00	0.00	0.00	4.82	208.24	286.38	353.22	349.01	151.04	6.70	12.83	0.00
		0.00	0.00	0.00	38.13	220.17	294.54	361.04	356.58	158.39	13.94	20.16	0.00
		0.00	0.00	0.00	78.82	228.69	303.13	367.62	361.71	162.60	17.56	23.82	2.02
	85% DFL	0.00	0.00	0.00	0.00	172.18	240.91	298.08	294.76	126.65	4.07	9.26	0.00
		0.00	0.00	0.00	22.53	184.12	249.07	305.89	302.32	134.00	11.31	16.59	0.00
		0.00	0.00	0.00	63.22	192.64	257.66	312.48	307.45	138.21	14.93	20.25	0.00
	75% DFL	0.00	0.00	0.00	0.00	148.14	210.60	261.32	258.59	110.39	2.31	6.87	0.00
		0.00	0.00	0.00	12.13	160.08	218.76	269.13	266.15	117.74	9.55	14.20	0.00
		0.00	0.00	0.00	52.82	168.60	227.35	275.71	271.28	121.95	13.17	17.87	0.00
	60% DFL	0.00	0.00	0.00	0.00	112.08	165.13	206.17	204.33	86.00	0.00	3.30	0.00
		0.00	0.00	0.00	0.00	124.02	173.29	213.99	211.90	93.35	6.92	10.63	0.00
		0.00	0.00	0.00	37.21	132.54	181.88	220.57	217.03	97.56	10.54	14.29	0.00
Kermanshah	100% DFL	0.00	0.00	0.00	0.00	0.00	74.37	116.13	120.75	56.18	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	34.30	88.84	125.40	125.83	61.81	4.47	0.41	0.00
		0.00	0.00	0.00	19.35	79.08	107.27	130.85	131.40	66.32	9.95	9.96	1.74
	85% DFL	0.00	0.00	0.00	0.00	0.00	56.89	95.64	101.04	46.24	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	19.61	71.37	104.92	106.12	51.86	2.64	0.00	0.00
		0.00	0.00	0.00	11.64	64.39	89.79	110.37	111.69	56.37	8.12	7.31	0.08
	75% DFL	0.00	0.00	0.00	0.00	0.00	45.24	81.99	87.90	39.60	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	9.81	59.72	91.26	92.98	45.23	1.42	0.00	0.00
		0.00	0.00	0.00	6.50	54.60	78.15	96.72	98.55	49.74	6.89	5.54	0.00
	60% DFL	0.00	0.00	0.00	0.00	0.00	27.77	61.51	68.19	29.66	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	42.25	70.78	73.27	35.29	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	39.91	60.67	76.24	78.84	39.79	5.06	2.89	0.00
Khuzestan	100% DFL	0.00	0.00	0.00	0.00	179.11	345.19	432.52	422.26	204.99	31.48	0.00	0.00
		0.00	0.00	0.00	0.00	225.01	364.93	443.85	433.00	214.66	40.80	20.30	0.00
		0.00	0.00	0.00	98.52	282.62	377.64	452.11	438.71	219.49	45.46	37.91	0.00
	85% DFL	0.00	0.00	0.00	0.00	131.34	287.70	364.71	356.46	172.07	24.66	0.00	0.00
		0.00	0.00	0.00	0.00	177.25	307.43	376.03	367.20	181.73	33.98	11.35	0.00
		0.00	0.00	0.00	73.90	234.85	320.15	384.29	372.91	186.57	38.64	28.97	0.00
	75% DFL	0.00	0.00	0.00	0.00	99.50	249.37	319.50	312.59	150.12	20.11	0.00	0.00
		0.00	0.00	0.00	0.00	145.40	269.10	330.82	323.33	159.78	29.43	5.39	0.00
		0.00	0.00	0.00	57.49	203.01	281.81	339.08	329.03	164.62	34.10	23.00	0.00
	60% DFL	0.00	0.00	0.00	0.00	51.73	191.87	251.68	246.78	117.19	13.29	0.00	0.00
		0.00	0.00	0.00	0.00	97.64	211.60	263.00	257.52	126.86	22.62	0.00	0.00
		0.00	0.00	0.00	32.88	155.24	224.32	271.27	263.23	131.69	27.28	14.05	0.00
Kohgiluieh	100% DFL	0.00	0.00	0.00	0.00	38.37	98.76	128.18	126.60	56.69	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	63.89	113.79	140.93	136.57	64.80	4.73	7.94	0.00
		0.00	0.00	0.00	13.15	86.29	124.90	147.30	141.56	68.86	8.44	14.53	0.00
	85% DFL	0.00	0.00	0.00	0.00	22.74	80.03	106.08	105.37	46.36	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	48.27	95.06	118.83	115.34	54.48	3.46	5.76	0.00
		0.00	0.00	0.00	5.32	70.66	106.17	125.21	120.32	58.53	7.18	12.35	0.00
	75% DFL	0.00	0.00	0.00	0.00	12.33	67.54	91.35	91.21	39.48	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	37.85	82.57	104.10	101.18	47.59	2.62	4.30	0.00
		0.00	0.00	0.00	0.10	60.25	93.68	110.48	106.17	51.65	6.33	10.89	0.00
	60% DFL	0.00	0.00	0.00	0.00	0.00	48.80	69.25	69.98	29.15	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	22.22	63.83	82.01	79.95	37.26	1.35	2.12	0.00
		0.00	0.00	0.00	0.00	44.62	74.94	88.38	84.94	41.32	5.07	8.72	0.00
Kordestan	100% DFL	0.00	0.00	0.00	0.00	0.00	0.00	39.78	58.58	19.05	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	13.52	62.41	72.11	32.20	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	17.01	52.14	73.32	83.03	42.00	7.90	0.00	0.00
	85% DFL	0.00	0.00	0.00	0.00	0.00	0.00	26.84	46.13	12.75	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	2.48	49.47	59.65	25.90	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	7.71	41.10	60.38	70.58	35.70	6.71	0.00	0.00
	75% DFL	0.00	0.00	0.00	0.00	0.00	0.00	18.21	37.82	8.55	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00	40.84	51.35	21.70	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	1.52	33.74	51.75	62.27	31.50	5.92	0.00	0.00
	60% DFL	0.00	0.00	0.00	0.00	0.00	0.00	5.27	25.37	2.25	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00	27.90	38.89	15.40	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	22.69	38.81	49.82	25.20	4.74	0.00	0.00
Lorestan	100% DFL	0.00	0.00	0.00	0.00	146.94	282.67	366.08	356.20	169.28	3.08	0.95	0.00
		0.00	0.00	0.00	0.00	197.24	306.69	386.10	377.28	180.12	17.35	25.98	0.00
		0.00	0.00	0.00	92.28	261.29	330.15	395.77	390.26	192.30	26.75	37.03	5.97
	85% DFL	0.00	0.00	0.00	0.00	103.57	230.79	304.99	297.47	140.43	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	153.88	254.82	325.01	318.56	151.27	13.34	19.47	0.00
		0.00	0.00	0.00	70.28	217.92	278.27	334.68	331.54	163.45	22.74	30.51	2.48

	75% DFL	0.00	0.00	0.00	0.00	74.66	196.20	264.27	258.32	121.20	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	124.97	220.23	284.29	279.41	132.04	10.66	15.12	0.00
		0.00	0.00	0.00	55.61	189.02	243.68	293.96	292.39	144.22	20.06	26.17	0.16
	60% DFL	0.00	0.00	0.00	0.00	31.30	144.33	203.19	199.60	92.36	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	81.61	168.35	223.20	220.69	103.20	6.65	8.61	0.00
		0.00	0.00	0.00	33.62	145.65	191.80	232.88	233.67	115.38	16.05	19.66	0.00
Markazi	100% DFL	0.00	0.00	0.00	6.54	74.32	98.73	113.22	115.09	57.35	6.52	10.66	1.94
		0.00	0.00	0.00	23.86	80.84	103.40	118.90	118.99	60.52	10.49	14.56	5.40
		2.60	1.33	0.00	41.91	89.71	108.36	126.71	122.86	62.10	12.22	16.23	8.56
	85% DFL	0.00	0.00	0.00	0.00	60.27	82.05	93.68	96.29	47.81	4.69	8.05	0.28
		0.00	0.00	0.00	16.44	66.80	86.72	99.36	100.19	50.98	8.66	11.95	3.73
		1.74	0.46	0.00	34.49	75.67	91.68	107.17	104.05	52.57	10.39	13.63	6.90
	75% DFL	0.00	0.00	0.00	0.00	50.91	70.93	80.66	83.75	41.45	3.47	6.31	0.00
		0.00	0.00	0.00	11.50	57.43	75.60	86.34	87.65	44.63	7.44	10.21	2.62
		1.17	0.00	0.00	29.55	66.31	80.56	94.14	91.52	46.21	9.16	11.89	5.78
	60% DFL	0.00	0.00	0.00	0.00	36.87	54.24	61.12	64.94	31.92	1.64	3.70	0.00
		0.00	0.00	0.00	4.09	43.39	58.91	66.80	68.84	35.09	5.60	7.60	0.95
		0.30	0.00	0.00	22.14	52.27	63.88	74.60	72.71	36.67	7.33	9.28	4.12
Mazandaran	100% DFL	0.00	0.00	0.00	0.00	0.00	51.38	86.42	90.51	31.35	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	16.26	72.21	97.40	99.93	41.97	0.00	0.00	0.00
		0.00	0.00	0.00	2.23	53.50	84.17	104.84	104.64	48.31	0.00	0.00	0.00
	85% DFL	0.00	0.00	0.00	0.00	0.00	38.46	70.70	74.82	24.10	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	6.14	59.29	81.68	84.24	34.72	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	43.38	71.25	89.11	88.95	41.06	0.00	0.00	0.00
	75% DFL	0.00	0.00	0.00	0.00	0.00	29.85	60.21	64.35	19.27	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	50.68	71.19	73.77	29.89	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	36.64	62.64	78.63	78.48	36.23	0.00	0.00	0.00
	60% DFL	0.00	0.00	0.00	0.00	0.00	16.93	44.49	48.66	12.03	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	37.76	55.47	58.08	22.64	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	26.51	49.72	62.90	62.79	28.99	0.00	0.00	0.00
NorthKhorasan	100% DFL	0.00	0.00	0.00	9.81	74.94	109.03	138.54	136.83	62.65	3.26	7.51	0.00
		0.00	0.00	0.00	25.39	85.07	114.18	142.27	139.60	65.54	7.00	11.13	3.15
		0.00	0.00	0.00	41.23	96.47	121.03	145.75	141.75	67.06	8.90	12.66	5.73
	85% DFL	0.00	0.00	0.00	2.21	59.43	90.19	116.18	115.15	52.21	1.74	5.27	0.00
		0.00	0.00	0.00	17.79	69.55	95.34	119.90	117.92	55.10	5.49	8.89	1.79
		0.00	0.00	0.00	33.63	80.96	102.19	123.39	120.07	56.63	7.38	10.42	4.37
	75% DFL	0.00	0.00	0.00	0.00	49.09	77.63	101.26	100.70	45.25	0.74	3.78	0.00
		0.00	0.00	0.00	12.72	59.21	82.78	104.99	103.47	48.14	4.48	7.39	0.88
		0.00	0.00	0.00	28.57	70.62	89.63	108.48	105.61	49.67	6.37	8.92	3.46
	60% DFL	0.00	0.00	0.00	0.00	33.58	58.79	78.90	79.02	34.81	0.00	1.54	0.00
		0.00	0.00	0.00	5.13	43.70	63.94	82.62	81.79	37.70	2.97	5.15	0.00
		0.00	0.00	0.00	20.97	55.11	70.80	86.11	83.93	39.23	4.86	6.68	2.10
RazaviKhorasan	100% DFL	0.00	0.00	0.00	41.96	195.24	263.31	324.19	317.40	149.59	15.81	26.24	7.62
		0.00	0.00	0.00	71.52	209.72	272.67	330.96	323.54	156.04	24.16	34.48	14.72
		3.93	0.00	0.00	102.41	228.37	282.04	336.70	327.23	159.65	29.00	39.00	19.96
	85% DFL	0.00	0.00	0.00	23.83	159.24	219.79	272.71	267.47	125.05	11.41	20.20	3.56
		0.00	0.00	0.00	53.38	173.72	229.16	279.48	273.61	131.49	19.76	28.44	10.67
		1.58	0.00	0.00	84.28	192.37	238.52	285.22	277.30	135.10	24.60	32.96	15.91
	75% DFL	0.00	0.00	0.00	11.74	135.23	190.79	238.39	234.18	108.68	8.48	16.17	0.86
		0.00	0.00	0.00	41.29	149.72	200.15	245.16	240.33	115.12	16.83	24.41	7.97
		0.02	0.00	0.00	72.19	168.37	209.52	250.90	244.02	118.74	21.67	28.93	13.21
	60% DFL	0.00	0.00	0.00	0.00	99.23	147.27	186.91	184.26	84.13	4.08	10.13	0.00
		0.00	0.00	0.00	23.16	113.71	156.64	193.68	190.40	90.57	12.43	18.37	3.91
		0.00	0.00	0.00	54.05	132.36	166.00	199.42	194.09	94.19	17.27	22.89	9.15
Semnan	100% DFL	0.00	0.00	0.00	2.93	33.59	49.77	62.80	62.01	29.18	2.45	3.75	0.00
		0.00	0.00	0.00	10.90	38.32	51.96	64.36	63.45	30.68	4.26	5.38	1.09
		0.75	0.00	0.00	18.91	43.70	54.78	65.70	64.26	31.67	5.19	6.38	3.34
	85% DFL	0.00	0.00	0.00	0.00	26.54	41.25	52.72	52.24	24.37	1.59	2.56	0.00
		0.00	0.00	0.00	7.35	31.27	43.44	54.28	53.68	25.88	3.40	4.20	0.30
		0.29	0.00	0.00	15.36	36.65	46.26	55.62	54.49	26.87	4.33	5.20	2.55
	75% DFL	0.00	0.00	0.00	0.00	21.84	35.57	46.01	45.72	21.17	1.01	1.78	0.00
		0.00	0.00	0.00	4.98	26.57	37.76	47.56	47.16	22.68	2.83	3.41	0.00
		0.00	0.00	0.00	13.00	31.96	40.58	48.91	47.97	23.66	3.75	4.41	2.02
	60% DFL	0.00	0.00	0.00	0.00	14.80	27.05	35.93	35.95	16.37	0.15	0.59	0.00
		0.00	0.00	0.00	1.43	19.53	29.24	37.49	37.39	17.87	1.97	2.23	0.00
		0.00	0.00	0.00	9.45	24.91	32.07	38.83	38.20	18.86	2.89	3.23	1.23
Sistan	100% DFL	0.00	0.00	0.00	0.00	110.05	153.55	189.50	187.84	79.92	1.20	4.43	0.00
		0.00	0.00	0.00	13.91	119.66	159.38	195.22	193.30	85.20	6.22	9.57	0.00
		0.00	0.00	0.00	39.67	125.28	164.51	199.69	196.46	87.85	8.73	12.14	0.00
	85% DFL	0.00	0.00	0.00	0.00	90.51	128.87	159.55	158.37	66.74	0.00	2.61	0.00
		0.00	0.00	0.00	5.53	100.12	134.71	165.27	163.83	72.03	4.91	7.75	0.00
		0.00	0.00	0.00	31.29	105.74	139.83	169.73	166.99	74.67	7.42	10.32	0.00
	75% DFL	0.00	0.00	0.00	0.00	77.48	112.42	139.58	138.72	57.96	0.00	1.40	0.00
		0.00	0.00	0.00	0.00	87.09	118.25	145.30	144.19	63.24	4.04	6.54	0.00
		0.00	0.00	0.00	25.70	92.71	123.38	149.77	147.35	65.89	6.55	9.11	0.00
	60% DFL	0.00	0.00	0.00	0.00	57.94	87.74	109.62	109.25	44.78	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	67.55	93.58	115.35	114.72	50.06	2.73	4.72	0.00
		0.00	0.00	0.00	17.31	73.17	98.71	119.81	117.88	52.71	5.24	7.29	0.00
SouthKhorasan	100% DFL	0.00	0.00	0.00	46.71	131.55	165.64	199.23	193.29	89.04	7.22	14.10	3.53
		0.00	0.00	0.00	53.74	134.51	167.55	201.19	195.35	91.17	8.84	15.66	6.00
		0.00	0.00	0.00	61.59	137.48	169.06	202.20	196.63	92.66	9.76	16.53	7.15
	85% DFL	0.00	0.00	0.00	36.75	110.55	139.99	168.66	163.68	75.12	5.76	11.62	2.28
		0.00	0.00	0.00	43.79	113.51	141.91	170.62	165.74	77.25	7.38	13.18	4.75
		0.00	0.00	0.00	51.64	116.48	143.42	171.63	167.02	78.74	8.30	14.05	5.90
	75% DFL	0.00	0.00	0.00	30.12	96.55	122.90	148.28	143.94	65.84	4.78	9.97	1.45
		0.00	0.00	0.00	37.15	99.50	124.81	150.24	146.00	67.97	6.40	11.53	3.92
		0.00	0.00	0.00	45.00	102.48	126.32	151.25	147.28	69.46	7.32	12.40	5.06
	60% DFL	0.00	0.00	0.00	20.16	75.55	97.25	117.71	114.33	51.92	3.32	7.49	0.20
		0.00	0.00	0.00	27.20	78.50	99.16	119.67	116.39	54.05	4.94	9.05	2.67
		0.00	0.00	0.00	35.05	81.48	100.67	120.68	117.67	55.54	5.86	9.92	3.82
Tehran	100% DFL	34.12	24.97	0.00	8.28	85.52	122.14	145.03	143.96	96.88	53.98	54.52	46.13
		42.64	34.78	3.47	40.48	99.20	128.45	149.65	149.00	99.83	60.06	60.27	50.93
		51.81	49.19	37.98	71.70	115.36	134.53	152.02	152.57	102.68	62.93	62.77	56.38
	85% DFL	25.29	16.14	0.00	0.00	66.73	101.12	121.66	121.04	81.48	44.54	44.59	36.79
		33.81	25.95	0.00	26.98	80.40	107.43	126.28	126.09	84.43	50.62	50.35	41.60
		42.97	40.36	29.15	58.20	96.56	113.52	128.64	129.65	87.28	53.49	52.84	47.05
	75% DFL	19.40	10.25	0.00	0.00	54.20	87.11	106.08	105.77	71.21	38.25	37.97	30.57
		27.92	20.06	0.00	17.98	67.87	93.42	110.70	110.81	74.16	44.33	43.73	35.37
		37.09	34.47	23.26	49.19	84.04	99.51	113.06	114.38	77.01	47.20	46.22	40.82
	60% DFL	10.57	1.42	0.00	0.00	35.40	66.10	82.70	82.85	55.81	28.81	28.05	21.23
		19.09	11.23	0.00	4.47	49.08	72.40	87.33	87.90	58.76	34.89	33.80	26.03
		28.25	25.64	14.43	35.69	65.24	78.49	89.69	91.46	61.61	37.76	36.30	31.49

Yazd	100% DFL	0.00	0.00	0.00	0.00	44.01	69.57	88.54	88.05	39.30	2.17	1.41	0.00
		0.00	0.00	0.00	1.03	50.28	73.40	92.27	92.00	41.68	5.17	6.24	0.00
		0.00	0.00	0.00	18.57	58.55	76.56	94.29	94.65	44.15	6.86	8.47	2.22
	85% DFL	0.00	0.00	0.00	0.00	34.39	57.53	74.01	73.75	32.68	1.14	0.14	0.00
		0.00	0.00	0.00	0.00	40.66	61.36	77.74	77.70	35.06	4.14	4.97	0.00
		0.00	0.00	0.00	14.21	48.92	64.52	79.76	80.36	37.52	5.83	7.20	1.24
	75% DFL	0.00	0.00	0.00	0.00	27.97	49.50	64.32	64.22	28.27	0.45	0.00	0.00
		0.00	0.00	0.00	0.00	34.24	53.33	68.05	68.17	30.65	3.46	4.12	0.00
		0.00	0.00	0.00	11.30	42.51	56.49	70.08	70.82	33.11	5.15	6.35	0.59
	60% DFL	0.00	0.00	0.00	0.00	18.35	37.46	49.80	49.92	21.64	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	24.62	41.29	53.53	53.87	24.02	2.43	2.85	0.00
		0.00	0.00	0.00	6.94	32.89	44.45	55.55	56.52	26.49	4.12	5.08	0.00
Zanjan	100% DFL	0.00	0.00	0.00	0.00	5.47	65.53	97.05	99.84	46.13	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	34.42	76.70	103.99	103.66	50.35	3.44	1.23	0.00
		0.00	0.00	0.00	18.00	66.53	88.80	107.99	107.93	53.77	7.79	7.73	0.94
	85% DFL	0.00	0.00	0.00	0.00	0.00	51.20	80.21	83.65	38.06	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	22.40	62.37	87.16	87.47	42.29	2.13	0.00	0.00
		0.00	0.00	0.00	11.80	54.52	74.47	91.15	91.74	45.71	6.47	5.74	0.00
	75% DFL	0.00	0.00	0.00	0.00	0.00	41.65	68.99	72.86	32.69	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	14.40	52.82	75.94	76.68	36.91	1.25	0.00	0.00
		0.00	0.00	0.00	7.66	46.51	64.92	79.93	80.95	40.33	5.60	4.41	0.00
	60% DFL	0.00	0.00	0.00	0.00	0.00	27.32	52.16	56.67	24.62	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	2.38	38.49	59.11	60.49	28.85	0.00	0.00	0.00
		0.00	0.00	0.00	1.46	34.50	50.59	63.10	64.76	32.26	4.28	2.41	0.00

- Climate zones (SWC):

Climate Zone	Demand fulfilment [%]	Surface water cap											
		January	February	March	April	May	June	July	August	September	October	November	December
Hyper arid	100% DFL	329.20	550.49	502.47	214.88	75.01	50.30	31.57	27.50	25.14	23.88	24.80	82.52
		232.19	379.73	347.71	141.44	48.19	22.82	15.34	11.86	9.84	7.96	8.31	54.60
		83.28	127.54	117.94	53.88	25.90	4.25	0.00	0.00	0.00	0.00	0.00	30.01
	85% DFL	329.20	550.49	502.47	214.88	75.01	50.30	31.57	27.50	25.14	23.88	24.80	82.52
		232.19	379.73	347.71	141.44	48.19	22.82	15.34	11.86	9.84	7.96	8.31	54.60
		83.28	127.54	117.94	53.88	25.90	4.25	0.00	0.00	0.00	0.00	0.00	30.01
	75% DFL	329.20	550.49	502.47	214.88	75.01	50.30	31.57	27.50	25.14	23.88	24.80	82.52
		232.19	379.73	347.71	141.44	48.19	22.82	15.34	11.86	9.84	7.96	8.31	54.60
		83.28	127.54	117.94	53.88	25.90	4.25	0.00	0.00	0.00	0.00	0.00	30.01
	60% DFL	329.20	550.49	502.47	214.88	75.01	50.30	31.57	27.50	25.14	23.88	24.80	82.52
		232.19	379.73	347.71	141.44	48.19	22.82	15.34	11.86	9.84	7.96	8.31	54.60
		83.28	127.54	117.94	53.88	25.90	4.25	0.00	0.00	0.00	0.00	0.00	30.01
Arid	100% DFL	1430.99	1714.54	1401.84	1227.89	505.56	207.28	111.33	92.58	82.71	83.66	136.58	658.07
		1005.15	1194.28	985.71	770.94	330.05	99.65	48.95	33.31	27.57	27.89	49.75	489.62
		355.55	412.26	349.72	288.93	144.46	30.08	0.00	0.00	0.00	0.00	0.00	200.97
	85% DFL	1430.99	1714.54	1401.84	1227.89	505.56	207.28	111.33	92.58	82.71	83.66	136.58	658.07
		1005.15	1194.28	985.71	770.94	330.05	99.65	48.95	33.31	27.57	27.89	49.75	489.62
		355.55	412.26	349.72	288.93	144.46	30.08	0.00	0.00	0.00	0.00	0.00	200.97
	75% DFL	1430.99	1714.54	1401.84	1227.89	505.56	207.28	111.33	92.58	82.71	83.66	136.58	658.07
		1005.15	1194.28	985.71	770.94	330.05	99.65	48.95	33.31	27.57	27.89	49.75	489.62
		355.55	412.26	349.72	288.93	144.46	30.08	0.00	0.00	0.00	0.00	0.00	200.97
	60% DFL	1430.99	1714.54	1401.84	1227.89	505.56	207.28	111.33	92.58	82.71	83.66	136.58	658.07
		1005.15	1194.28	985.71	770.94	330.05	99.65	48.95	33.31	27.57	27.89	49.75	489.62
		355.55	412.26	349.72	288.93	144.46	30.08	0.00	0.00	0.00	0.00	0.00	200.97
Semi arid	100% DFL	1242.14	1552.98	2283.63	2957.97	2037.51	886.34	334.86	152.43	123.56	128.00	211.68	574.94
		881.12	1083.33	1558.64	1906.84	1308.05	559.18	149.61	55.64	41.19	42.67	84.07	386.63
		276.59	324.21	436.14	507.09	366.08	189.72	45.50	0.00	0.00	0.00	0.00	160.14
	85% DFL	1242.14	1552.98	2283.63	2957.97	2037.51	886.34	334.86	152.43	123.56	128.00	211.68	574.94
		881.12	1083.33	1558.64	1906.84	1308.05	559.18	149.61	55.64	41.19	42.67	84.07	386.63
		276.59	324.21	436.14	507.09	366.08	189.72	45.50	0.00	0.00	0.00	0.00	160.14
	75% DFL	1242.14	1552.98	2283.63	2957.97	2037.51	886.34	334.86	152.43	123.56	128.00	211.68	574.94
		881.12	1083.33	1558.64	1906.84	1308.05	559.18	149.61	55.64	41.19	42.67	84.07	386.63
		276.59	324.21	436.14	507.09	366.08	189.72	45.50	0.00	0.00	0.00	0.00	160.14
	60% DFL	1242.14	1552.98	2283.63	2957.97	2037.51	886.34	334.86	152.43	123.56	128.00	211.68	574.94
		881.12	1083.33	1558.64	1906.84	1308.05	559.18	149.61	55.64	41.19	42.67	84.07	386.63
		276.59	324.21	436.14	507.09	366.08	189.72	45.50	0.00	0.00	0.00	0.00	160.14
Dry sub-humid	100% DFL	23.06	31.49	38.60	28.99	13.29	5.77	3.77	2.32	2.90	8.49	17.22	24.05
		16.43	21.61	25.54	18.36	8.56	2.73	2.17	0.77	1.17	5.20	12.75	17.21
		6.59	8.46	9.88	7.00	3.86	0.86	0.00	0.00	0.00	3.09	5.37	6.87
	85% DFL	23.06	31.49	38.60	28.99	13.29	5.77	3.77	2.32	2.90	8.49	17.22	24.05
		16.43	21.61	25.54	18.36	8.56	2.73	2.17	0.77	1.17	5.20	12.75	17.21
		6.59	8.46	9.88	7.00	3.86	0.86	0.00	0.00	0.00	3.09	5.37	6.87
	75% DFL	23.06	31.49	38.60	28.99	13.29	5.77	3.77	2.32	2.90	8.49	17.22	24.05
		16.43	21.61	25.54	18.36	8.56	2.73	2.17	0.77	1.17	5.20	12.75	17.21
		6.59	8.46	9.88	7.00	3.86	0.86	0.00	0.00	0.00	3.09	5.37	6.87
	60% DFL	23.06	31.49	38.60	28.99	13.29	5.77	3.77	2.32	2.90	8.49	17.22	24.05
		16.43	21.61	25.54	18.36	8.56	2.73	2.17	0.77	1.17	5.20	12.75	17.21
		6.59	8.46	9.88	7.00	3.86	0.86	0.00	0.00	0.00	3.09	5.37	6.87
Humid	100% DFL	996.70	424.28	328.24	326.30	161.51	51.41	33.91	26.44	26.09	39.47	106.21	281.13
		587.81	281.05	227.06	215.89	99.55	27.57	11.97	8.81	8.70	13.16	57.10	197.06
		131.76	65.72	54.10	46.96	27.95	0.00	0.00	0.00	0.00	0.00	22.28	47.34
	85% DFL	996.70	424.28	328.24	326.30	161.51	51.41	33.91	26.44	26.09	39.47	106.21	281.13
		587.81	281.05	227.06	215.89	99.55	27.57	11.97	8.81	8.70	13.16	57.10	197.06
		131.76	65.72	54.10	46.96	27.95	0.00	0.00	0.00	0.00	0.00	22.28	47.34
	75% DFL	996.70	424.28	328.24	326.30	161.51	51.41	33.91	26.44	26.09	39.47	106.21	281.13
		587.81	281.05	227.06	215.89	99.55	27.57	11.97	8.81	8.70	13.16	57.10	197.06
		131.76	65.72	54.10	46.96	27.95	0.00	0.00	0.00	0.00	0.00	22.28	47.34
	60% DFL	996.70	424.28	328.24	326.30	161.51	51.41	33.91	26.44	26.09	39.47	106.21	281.13
		587.81	281.05	227.06	215.89	99.55	27.57	11.97	8.81	8.70	13.16	57.10	197.06
		131.76	65.72	54.10	46.96	27.95	0.00	0.00	0.00	0.00	0.00	22.28	47.34

- Climate zones (GWC):

Climate Zone	Demand fulfilment [%]	Groundwater cap											
		January	February	March	April	May	June	July	August	September	October	November	December
Hyper arid	100% DFL	0.00	0.00	0.00	0.00	349.35	484.35	616.44	610.13	262.50	8.80	18.89	0.00
		0.00	0.00	0.00	43.22	376.16	511.84	632.67	625.76	277.79	24.73	35.38	0.00
		0.00	0.00	0.00	130.79	398.45	530.41	648.01	637.62	287.63	32.69	43.69	0.35
	85% DFL	0.00	0.00	0.00	0.00	285.69	404.15	519.24	514.48	219.35	3.90	12.34	0.00
		0.00	0.00	0.00	15.52	312.51	431.64	535.47	530.12	234.64	19.82	28.83	0.00
		0.00	0.00	0.00	103.09	334.80	450.21	550.81	541.98	244.49	27.78	37.14	0.00
	75% DFL	0.00	0.00	0.00	0.00	243.26	350.69	454.44	450.72	190.59	0.63	7.97	0.00
		0.00	0.00	0.00	0.00	270.07	378.17	470.67	466.36	205.88	16.55	24.46	0.00
		0.00	0.00	0.00	84.62	292.36	396.75	486.01	478.22	215.72	24.52	32.77	0.00
	60% DFL	0.00	0.00	0.00	0.00	179.60	270.49	357.24	355.08	147.44	0.00	1.42	0.00
		0.00	0.00	0.00	0.00	206.42	297.97	373.47	370.71	162.74	11.65	17.91	0.00
		0.00	0.00	0.00	56.92	228.71	316.55	388.81	382.57	172.58	19.61	26.21	0.00
Arid	100% DFL	0.00	0.00	0.00	0.00	1312.02	1993.28	2494.99	2436.15	1154.47	130.99	160.27	0.00
		0.00	0.00	0.00	138.07	1487.52	2100.90	2557.37	2495.42	1209.61	186.76	247.10	0.00
		0.00	0.00	0.00	620.08	1673.12	2170.47	2606.32	2528.73	1237.18	214.64	296.85	0.00
	85% DFL	0.00	0.00	0.00	0.00	1039.38	1663.19	2104.04	2056.84	968.89	98.79	115.74	0.00
		0.00	0.00	0.00	1.72	1214.89	1770.82	2166.42	2116.11	1024.03	154.56	202.57	0.00
		0.00	0.00	0.00	483.73	1400.48	1840.39	2215.37	2149.42	1051.60	182.45	252.32	0.00
	75% DFL	0.00	0.00	0.00	0.00	857.63	1443.14	1843.41	1803.97	845.18	77.33	86.05	0.00
		0.00	0.00	0.00	0.00	1033.13	1550.76	1905.79	1863.24	900.32	133.10	172.88	0.00
		0.00	0.00	0.00	392.83	1218.72	1620.33	1954.74	1896.54	927.88	160.98	222.64	0.00
	60% DFL	0.00	0.00	0.00	0.00	584.99	1113.06	1452.46	1424.66	659.60	45.13	41.53	0.00
		0.00	0.00	0.00	0.00	760.49	1220.68	1514.84	1483.93	714.74	100.90	128.36	0.00
		0.00	0.00	0.00	256.48	946.09	1290.25	1563.79	1517.24	742.31	128.79	178.11	0.00
Semi arid	100% DFL	0.00	0.00	0.00	0.00	0.00	384.92	1156.08	1282.19	598.13	1.17	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	712.08	1341.34	1378.98	680.50	86.51	104.78	0.00
		0.00	0.00	0.00	51.24	702.04	1081.54	1445.45	1434.62	721.69	129.18	188.85	0.00
	85% DFL	0.00	0.00	0.00	0.00	0.00	194.23	932.44	1067.00	489.87	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	521.39	1117.69	1163.79	572.25	67.13	76.45	0.00
		0.00	0.00	0.00	0.00	541.83	890.85	1221.80	1219.43	613.44	109.80	160.52	0.00
	75% DFL	0.00	0.00	0.00	0.00	0.00	67.10	783.35	923.54	417.70	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	394.27	968.60	1020.33	500.08	54.22	57.56	0.00
		0.00	0.00	0.00	0.00	435.01	763.72	1072.71	1075.97	541.27	96.88	141.63	0.00
	60% DFL	0.00	0.00	0.00	0.00	0.00	0.00	559.70	708.34	309.45	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	203.58	744.96	805.13	391.83	34.84	29.24	0.00
		0.00	0.00	0.00	0.00	274.80	573.03	849.07	860.77	433.01	77.51	113.31	0.00
Dry sub-humid	100% DFL	0.00	0.00	0.00	11.44	68.16	93.07	113.45	111.49	52.50	0.88	0.00	0.00
		0.00	0.00	0.00	22.06	72.89	96.11	115.05	113.04	54.23	4.16	0.23	0.00
		0.00	0.00	0.00	33.42	77.59	97.97	117.22	113.82	55.40	6.28	7.61	1.73
	85% DFL	0.00	0.00	0.00	5.37	55.94	78.25	95.87	94.42	44.19	0.00	0.00	0.00
		0.00	0.00	0.00	16.00	60.67	81.29	97.47	95.97	45.92	2.76	0.00	0.00
		0.00	0.00	0.00	27.36	65.37	83.15	99.64	96.74	47.09	4.87	5.66	0.44
	75% DFL	0.00	0.00	0.00	1.33	47.80	68.36	84.14	83.04	38.65	0.00	0.00	0.00
		0.00	0.00	0.00	11.96	52.53	71.40	85.74	84.59	40.38	1.82	0.00	0.00
		0.00	0.00	0.00	23.32	57.23	73.27	87.92	85.36	41.55	3.94	4.36	0.00
	60% DFL	0.00	0.00	0.00	0.00	35.58	53.54	66.56	65.97	30.34	0.00	0.00	0.00
		0.00	0.00	0.00	5.89	40.31	56.58	68.16	67.52	32.07	0.42	0.00	0.00
		0.00	0.00	0.00	17.25	45.01	58.44	70.33	68.29	33.24	2.53	2.42	0.00
Humid	100% DFL	0.00	0.00	0.00	0.00	0.00	87.64	134.93	142.08	52.77	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	9.81	111.48	156.87	159.71	70.16	5.27	0.00	0.00
		0.00	0.00	0.00	2.42	81.40	139.05	168.84	168.52	78.86	18.42	0.00	0.00
	85% DFL	0.00	0.00	0.00	0.00	0.00	66.78	109.60	116.80	40.94	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	90.62	131.54	134.43	58.33	2.50	0.00	0.00
		0.00	0.00	0.00	0.00	65.00	118.19	143.51	143.24	67.03	15.66	0.00	0.00
	75% DFL	0.00	0.00	0.00	0.00	0.00	52.87	92.72	99.95	33.06	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	76.72	114.66	117.58	50.45	0.66	0.00	0.00
		0.00	0.00	0.00	0.00	54.06	104.29	126.63	126.39	59.14	13.82	0.00	0.00
	60% DFL	0.00	0.00	0.00	0.00	0.00	32.02	67.39	74.67	21.23	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	55.86	89.33	92.30	38.62	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	37.66	83.43	101.30	101.11	47.31	11.05	0.00	0.00

B.3 Implications of each scenario for each province

Province	Scenario Names	WF cap option		UFD [%]	EFR_{SW} violation						Groundwater overuse		
		DFL [%]	SW cap		Annual violated volume (range by EFR_{SW} methods) [million m^3 y^{-1}]	Annual violated volume (average by EFR_{SW} methods) [million m^3 y^{-1}]	Monthly violation (average by EFR_{SW} methods) [%]	Annual violation (average by EFR_{SW} methods) [%]	# mo y^{-1} (average by EFR_{SW} methods)	# 90 mo (average by EFR_{SW} methods)	Annual violated volume (range by EFR_{GW} methods) [million m^3 y^{-1}]	Annual violated volume (average by EFR_{GW} methods) [million m^3 y^{-1}]	Annual violation (average by EFR_{GW} methods) [%]
Ardebil	**A1**	100% DFL	max BWA_{SW}	0%	79.88-1165.31	521.19	50%-100%	87%	11.5	5.2	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}	0%	0.00-646.83	193.77	3%-10%	0%	6.6	0.4	0.00-0.00	0.00	0%
	A3		min BWA_{SW}	0%	0.00-3.18	0.53	0%-0%	0%	1.0	0.0	282.54-395.06	338.80	100%
	B1	85% DFL	max BWA_{SW}	2%	79.88-1165.31	521.19	50%-100%	87%	11.5	5.2	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}	2%	0.00-646.83	193.77	3%-10%	0%	6.6	0.4	0.00-0.00	0.00	0%
	B3		min BWA_{SW}	2%	0.00-3.18	0.53	0%-0%	0%	1.0	0.0	263.08-375.60	319.34	100%
	C1	75% DFL	max BWA_{SW}	3%	79.88-1165.31	521.19	50%-100%	87%	11.5	5.2	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}	3%	0.00-646.83	193.77	3%-10%	0%	6.6	0.4	0.00-0.00	0.00	0%
	C3		min BWA_{SW}	3%	0.00-3.18	0.53	0%-0%	0%	1.0	0.0	245.02-357.54	301.28	100%
	D1	60% DFL	max BWA_{SW}	9%	79.88-1165.31	521.19	50%-100%	87%	11.5	5.2	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}	9%	0.00-646.83	193.77	3%-10%	0%	6.6	0.4	0.00-0.00	0.00	0%
	D3		min BWA_{SW}	9%	0.00-3.18	0.53	0%-0%	0%	1.0	0.0	194.43-306.95	250.69	100%
WestAzarbaijan	**A1**	100% DFL	max BWA_{SW}	0%	741.26-4975.51	2552.67	51%-100%	100%	11.5	5.0	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}	0%	0.00-2438.90	731.82	4%-11%	0%	6.6	0.2	0.00-0.00	0.00	0%
	A3		min BWA_{SW}	0%	0.00-0.00	0.00	0%-0%	0%	1.0	0.0	0.00-0.00	0.00	0%
	B1	85% DFL	max BWA_{SW}	1%	741.26-4975.51	2552.67	51%-100%	100%	11.5	5.0	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}	1%	0.00-2438.90	731.82	4%-11%	0%	6.6	0.2	0.00-0.00	0.00	0%
	B3		min BWA_{SW}	1%	0.00-0.00	0.00	0%-0%	0%	1.0	0.0	0.00-0.00	0.00	0%
	C1	75% DFL	max BWA_{SW}	2%	741.26-4975.51	2552.67	51%-100%	100%	11.5	5.0	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}	2%	0.00-2438.90	731.82	4%-11%	0%	6.6	0.2	0.00-0.00	0.00	0%
	C3		min BWA_{SW}	2%	0.00-0.00	0.00	0%-0%	0%	1.0	0.0	0.00-0.00	0.00	0%
	D1	60% DFL	max BWA_{SW}	6%	741.26-4975.51	2552.67	51%-100%	100%	11.5	5.0	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}	6%	0.00-2438.90	731.82	4%-11%	0%	6.6	0.2	0.00-0.00	0.00	0%
	D3		min BWA_{SW}	6%	0.00-0.00	0.00	0%-0%	0%	1.0	0.0	0.00-0.00	0.00	0%
EastAzarbaijan	**A1**	100% DFL	max BWA_{SW}	0%	304.09-1720.57	932.87	0%-100%	100%	10.8	4.9	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}	0%	0.00-792.14	245.96	5%-29%	0%	6.7	0.8	287.69-518.21	402.95	100%
	A3		min BWA_{SW}	0%	0.00-0.00	0.00	0%-0%	0%	1.6	0.0	1146.15-1376.67	1261.41	100%
	B1	85% DFL	max BWA_{SW}	1%	304.09-1720.57	932.87	0%-100%	100%	10.8	4.9	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}	1%	0.00-792.14	245.96	5%-29%	0%	6.7	0.8	262.59-493.11	377.85	100%
	B3		min BWA_{SW}	1%	0.00-0.00	0.00	0%-0%	0%	1.6	0.0	1121.05-1351.57	1236.31	100%
	C1	75% DFL	max BWA_{SW}	2%	304.09-1720.57	932.87	0%-100%	100%	10.8	4.9	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}	2%	0.00-792.14	245.96	5%-29%	0%	6.7	0.8	226.71-457.23	341.97	99%
	C3		min BWA_{SW}	2%	0.00-0.00	0.00	0%-0%	0%	1.6	0.0	1085.17-1315.69	1200.43	100%
	D1	60% DFL	max BWA_{SW}	7%	304.09-1720.57	932.87	0%-100%	100%	10.8	4.9	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}	7%	0.00-792.14	245.96	5%-29%	0%	6.7	0.8	94.00-324.53	209.27	57%
	D3		min BWA_{SW}	7%	0.00-0.00	0.00	0%-0%	0%	1.6	0.0	952.46-1182.99	1067.73	100%
Bushehr	**A1**		max BWA_{SW}	0%	96.96-603.95	304.27	0%-100%	100%	11.3	6.6	0.00-0.00	0.00	0%

	A2	100% DFL	ave BWA_{SW}	0%	0.00-323.20	101.51	6%-83%	5%	8.7	1.4	0.00-85.29	30.59	9%
	A3		min BWA_{SW}	0%	0.00-15.48	2.58	0%-56%	0%	5.0	0.2	248.42-393.01	320.72	100%
	B1	85% DFL	max BWA_{SW}	1%	96.96-603.95	304.27	0%-100%	100%	11.3	6.6	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}	1%	0.00-323.20	101.51	6%-83%	5%	8.7	1.4	0.00-78.55	27.23	8%
	B3		min BWA_{SW}	1%	0.00-15.48	2.58	0%-56%	0%	5.0	0.2	241.69-386.28	313.98	100%
	C1	75% DFL	max BWA_{SW}	3%	96.96-603.95	304.27	0%-100%	100%	11.3	6.6	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}	3%	0.00-323.20	101.51	6%-83%	5%	8.7	1.4	0.00-61.89	18.90	5%
	C3		min BWA_{SW}	3%	0.00-15.48	2.58	0%-56%	0%	5.0	0.2	225.02-369.62	297.32	100%
	D1	60% DFL	max BWA_{SW}	10%	96.96-603.95	304.27	0%-100%	100%	11.3	6.6	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}	10%	0.00-323.20	101.51	6%-83%	5%	8.7	1.4	0.00-0.00	0.00	0%
	D3		min BWA_{SW}	10%	0.00-15.48	2.58	0%-56%	0%	5.0	0.2	161.82-306.41	234.12	100%
Chaharmahal	**A1**	100% DFL	max BWA_{SW}	0%	586.92-4093.27	1956.09	47%-100%	100%	11.8	5.7	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}	0%	0.00-2208.33	639.86	4%-40%	2%	7.5	0.3	0.00-0.00	0.00	0%
	A3		min BWA_{SW}	0%	0.00-159.50	26.58	0%-20%	0%	2.4	0.0	0.00-0.00	0.00	0%
	B1	85% DFL	max BWA_{SW}	1%	586.92-4093.27	1956.09	47%-100%	100%	11.8	5.7	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}	1%	0.00-2208.33	639.86	4%-40%	2%	7.5	0.3	0.00-0.00	0.00	0%
	B3		min BWA_{SW}	1%	0.00-159.50	26.58	0%-20%	0%	2.4	0.0	0.00-0.00	0.00	0%
	C1	75% DFL	max BWA_{SW}	2%	586.92-4093.27	1956.09	47%-100%	100%	11.8	5.7	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}	2%	0.00-2208.33	639.86	4%-40%	2%	7.5	0.3	0.00-0.00	0.00	0%
	C3		min BWA_{SW}	2%	0.00-159.50	26.58	0%-20%	0%	2.4	0.0	0.00-0.00	0.00	0%
	D1	60% DFL	max BWA_{SW}	6%	586.92-4093.27	1956.09	47%-100%	100%	11.8	5.7	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}	6%	0.00-2208.33	639.86	4%-40%	2%	7.5	0.3	0.00-0.00	0.00	0%
	D3		min BWA_{SW}	6%	0.00-159.50	26.58	0%-20%	0%	2.4	0.0	0.00-0.00	0.00	0%
Esfahan	**A1**	100% DFL	max BWA_{SW}	0%	412.12-3077.50	1589.58	0%-100%	100%	10.9	5.3	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}	0%	0.00-1498.84	466.07	6%-27%	0%	6.7	0.8	0.00-0.00	0.00	0%
	A3		min BWA_{SW}	0%	0.00-0.00	0.00	0%-0%	0%	1.3	0.0	0.00-451.16	152.87	7%
	B1	85% DFL	max BWA_{SW}	1%	412.12-3077.50	1589.58	0%-100%	100%	10.9	5.3	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}	1%	0.00-1498.84	466.07	6%-27%	0%	6.7	0.8	0.00-0.00	0.00	0%
	B3		min BWA_{SW}	1%	0.00-0.00	0.00	0%-0%	0%	1.3	0.0	0.00-427.67	141.12	6%
	C1	75% DFL	max BWA_{SW}	2%	412.12-3077.50	1589.58	0%-100%	100%	10.9	5.3	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}	2%	0.00-1498.84	466.07	6%-27%	0%	6.7	0.8	0.00-0.00	0.00	0%
	C3		min BWA_{SW}	2%	0.00-0.00	0.00	0%-0%	0%	1.3	0.0	0.00-402.79	128.68	6%
	D1	60% DFL	max BWA_{SW}	7%	412.12-3077.50	1589.58	0%-100%	100%	10.9	5.3	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}	7%	0.00-1498.84	466.07	6%-27%	0%	6.7	0.8	0.00-0.00	0.00	0%
	D3		min BWA_{SW}	7%	0.00-0.00	0.00	0%-0%	0%	1.3	0.0	0.00-302.39	78.48	3%
Fars	**A1**	100% DFL	max BWA_{SW}	0%	530.99-3275.58	1685.64	0%-100%	100%	11.4	6.4	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}	0%	0.00-1700.79	545.43	7%-64%	4%	8.4	1.2	0.00-537.40	134.35	2%
	A3		min BWA_{SW}	0%	0.00-4.21	0.70	0%-41%	0%	4.4	0.1	0.00-2233.98	1051.78	20%
	B1	85% DFL	max BWA_{SW}	1%	530.99-3275.58	1685.64	0%-100%	100%	11.4	6.4	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}	1%	0.00-1700.79	545.43	7%-64%	4%	8.4	1.2	0.00-484.42	121.10	2%
	B3		min BWA_{SW}	1%	0.00-4.21	0.70	0%-41%	0%	4.4	0.1	0.00-2180.99	1012.05	19%
	C1	75% DFL	max BWA_{SW}	3%	530.99-3275.58	1685.64	0%-100%	100%	11.4	6.4	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}	3%	0.00-1700.79	545.43	7%-64%	4%	8.4	1.2	0.00-371.07	92.77	1%
	C3		min BWA_{SW}	3%	0.00-4.21	0.70	0%-41%	0%	4.4	0.1	0.00-2067.65	927.04	17%
	D1	60% DFL	max BWA_{SW}	9%	530.99-3275.58	1685.64	0%-100%	100%	11.4	6.4	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}	9%	0.00-1700.79	545.43	7%-64%	4%	8.4	1.2	0.00-41.54	10.38	0%
	D3		min BWA_{SW}	9%	0.00-4.21	0.70	0%-41%	0%	4.4	0.1	0.00-1738.12	679.89	12%
Qazvin	**A1**	100% DFL	max BWA_{SW}	0%	119.47-901.95	446.35	0%-100%	100%	11.5	5.3	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}	0%	0.00-457.03	138.69	3%-11%	0%	6.6	0.2	0.00-0.00	0.00	0%

	A3		min BWA_{SW}	0%	0.00-0.00	0.00	0%-0%	0%	1.0	0.0	0.00-373.78	146.30	12%
	B1	85% DFL	max BWA_{SW}	2%	119.47-901.95	446.35	0%-100%	100%	11.5	5.3	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}	2%	0.00-457.03	138.69	3%-11%	0%	6.6	0.2	0.00-0.00	0.00	0%
	B3		min BWA_{SW}	2%	0.00-0.00	0.00	0%-0%	0%	1.0	0.0	0.00-349.47	130.06	10%
	C1	75% DFL	max BWA_{SW}	5%	119.47-901.95	446.35	0%-100%	100%	11.5	5.3	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}	5%	0.00-457.03	138.69	3%-11%	0%	6.6	0.2	0.00-0.00	0.00	0%
	C3		min BWA_{SW}	5%	0.00-0.00	0.00	0%-0%	0%	1.0	0.0	0.00-317.30	113.97	9%
	D1	60% DFL	max BWA_{SW}	15%	119.47-901.95	446.35	0%-100%	100%	11.5	5.3	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}	15%	0.00-457.03	138.69	3%-11%	0%	6.6	0.2	0.00-0.00	0.00	0%
	D3		min BWA_{SW}	15%	0.00-0.00	0.00	0%-0%	0%	1.0	0.0	0.00-232.53	71.59	5%
Qom	**A1**	100% DFL	max BWA_{SW}	0%	9.01-59.25	30.42	0%-100%	100%	10.8	5.9	83.22-170.21	126.71	98%
	A2		ave BWA_{SW}	0%	0.00-28.90	8.67	7%-27%	0%	6.6	1.0	113.57-200.57	157.07	100%
	A3		min BWA_{SW}	0%	0.00-0.00	0.00	0%-0%	0%	1.3	0.0	144.25-231.24	187.74	100%
	B1	85% DFL	max BWA_{SW}	2%	9.01-59.25	30.42	0%-100%	100%	10.8	5.9	76.42-163.42	119.92	95%
	B2		ave BWA_{SW}	2%	0.00-28.90	8.67	7%-27%	0%	6.6	1.0	106.78-193.77	150.28	100%
	B3		min BWA_{SW}	2%	0.00-0.00	0.00	0%-0%	0%	1.3	0.0	137.45-224.45	180.95	100%
	C1	75% DFL	max BWA_{SW}	5%	9.01-59.25	30.42	0%-100%	100%	10.8	5.9	64.52-151.52	108.02	86%
	C2		ave BWA_{SW}	5%	0.00-28.90	8.67	7%-27%	0%	6.6	1.0	94.88-181.87	138.38	100%
	C3		min BWA_{SW}	5%	0.00-0.00	0.00	0%-0%	0%	1.3	0.0	125.55-212.55	169.05	100%
	D1	60% DFL	max BWA_{SW}	14%	9.01-59.25	30.42	0%-100%	100%	10.8	5.9	31.60-118.60	75.10	53%
	D2		ave BWA_{SW}	14%	0.00-28.90	8.67	7%-27%	0%	6.6	1.0	61.96-148.95	105.46	84%
	D3		min BWA_{SW}	14%	0.00-0.00	0.00	0%-0%	0%	1.3	0.0	92.63-179.63	136.13	100%
Gilan	**A1**	100% DFL	max BWA_{SW}	1%	264.72-3218.73	1404.16	47%-100%	90%	11.9	4.4	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}	1%	0.00-1831.19	520.38	2%-7%	1%	6.3	0.0	0.00-0.00	0.00	0%
	A3		min BWA_{SW}	1%	0.00-33.93	5.65	0%-0%	0%	0.8	0.0	0.00-0.00	0.00	0%
	B1	85% DFL	max BWA_{SW}	4%	264.72-3218.73	1404.16	47%-100%	90%	11.9	4.4	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}	4%	0.00-1831.19	520.38	2%-7%	1%	6.3	0.0	0.00-0.00	0.00	0%
	B3		min BWA_{SW}	4%	0.00-33.93	5.65	0%-0%	0%	0.8	0.0	0.00-0.00	0.00	0%
	C1	75% DFL	max BWA_{SW}	9%	264.72-3218.73	1404.16	47%-100%	90%	11.9	4.4	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}	9%	0.00-1831.19	520.38	2%-7%	1%	6.3	0.0	0.00-0.00	0.00	0%
	C3		min BWA_{SW}	9%	0.00-33.93	5.65	0%-0%	0%	0.8	0.0	0.00-0.00	0.00	0%
	D1	60% DFL	max BWA_{SW}	20%	264.72-3218.73	1404.16	47%-100%	90%	11.9	4.4	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}	20%	0.00-1831.19	520.38	2%-7%	1%	6.3	0.0	0.00-0.00	0.00	0%
	D3		min BWA_{SW}	20%	0.00-33.93	5.65	0%-0%	0%	0.8	0.0	0.00-0.00	0.00	0%
Gorgan	**A1**	100% DFL	max BWA_{SW}	0%	26.86-373.33	178.63	0%-100%	79%	11.2	4.8	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}	0%	0.00-195.84	65.14	5%-23%	0%	6.3	0.6	0.00-139.16	46.42	7%
	A3		min BWA_{SW}	0%	0.00-0.00	0.00	0%-0%	0%	1.5	0.0	71.94-349.86	210.90	44%
	B1	85% DFL	max BWA_{SW}	1%	26.86-373.33	178.63	0%-100%	79%	11.2	4.8	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}	1%	0.00-195.84	65.14	5%-23%	0%	6.3	0.6	0.00-120.66	37.17	5%
	B3		min BWA_{SW}	1%	0.00-0.00	0.00	0%-0%	0%	1.5	0.0	53.43-331.36	192.39	38%
	C1	75% DFL	max BWA_{SW}	3%	26.86-373.33	178.63	0%-100%	79%	11.2	4.8	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}	3%	0.00-195.84	65.14	5%-23%	0%	6.3	0.6	0.00-99.61	26.65	4%
	C3		min BWA_{SW}	3%	0.00-0.00	0.00	0%-0%	0%	1.5	0.0	32.38-310.31	171.35	33%
	D1	60% DFL	max BWA_{SW}	7%	26.86-373.33	178.63	0%-100%	79%	11.2	4.8	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}	7%	0.00-195.84	65.14	5%-23%	0%	6.3	0.6	0.00-58.44	14.61	2%
	D3		min BWA_{SW}	7%	0.00-0.00	0.00	0%-0%	0%	1.5	0.0	0.00-269.14	132.37	23%
Hamedan	**A1**	100% DFL	max BWA_{SW}	0%	34.71-250.50	125.15	39%-100%	100%	11.5	5.4	133.57-694.41	413.99	42%
	A2		ave BWA_{SW}	0%	0.00-125.57	38.09	3%-11%	0%	6.6	0.2	258.50-819.34	538.92	62%
	A3		min BWA_{SW}	0%	0.00-0.00	0.00	0%-0%	0%	0.7	0.0	387.95-948.79	668.37	83%

	B1	85% DFL	max BWA_{SW}	1%	34.71-250.50	125.15	39%-100%	100%	11.5	5.4	116.08-676.92	396.50	39%
	B2		ave BWA_{SW}	1%	0.00-125.57	38.09	3%-11%	0%	6.6	0.2	241.00-801.84	521.42	59%
	B3		min BWA_{SW}	1%	0.00-0.00	0.00	0%-0%	0%	0.7	0.0	370.45-931.29	650.87	81%
	C1	75% DFL	max BWA_{SW}	4%	34.71-250.50	125.15	39%-100%	100%	11.5	5.4	76.72-637.57	357.15	34%
	C2		ave BWA_{SW}	4%	0.00-125.57	38.09	3%-11%	0%	6.6	0.2	201.65-762.49	482.07	52%
	C3		min BWA_{SW}	4%	0.00-0.00	0.00	0%-0%	0%	0.7	0.0	331.10-891.94	611.52	74%
	D1	60% DFL	max BWA_{SW}	11%	34.71-250.50	125.15	39%-100%	100%	11.5	5.4	0.00-525.20	253.69	22%
	D2		ave BWA_{SW}	11%	0.00-125.57	38.09	3%-11%	0%	6.6	0.2	89.29-650.13	369.71	36%
	D3		min BWA_{SW}	11%	0.00-0.00	0.00	0%-0%	0%	0.7	0.0	218.74-779.58	499.16	55%
Hormozgan	**A1**	100% DFL	max BWA_{SW}	0%	181.08-1034.25	536.53	0%-100%	100%	11.2	6.0	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}	0%	0.00-531.43	168.80	6%-60%	4%	8.3	1.0	0.00-0.00	0.00	0%
	A3		min BWA_{SW}	0%	0.00-6.78	1.13	0%-37%	0%	4.4	0.1	137.39-426.57	281.98	64%
	B1	85% DFL	max BWA_{SW}	1%	181.08-1034.25	536.53	0%-100%	100%	11.2	6.0	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}	1%	0.00-531.43	168.80	6%-60%	4%	8.3	1.0	0.00-0.00	0.00	0%
	B3		min BWA_{SW}	1%	0.00-6.78	1.13	0%-37%	0%	4.4	0.1	127.95-417.13	272.54	61%
	C1	75% DFL	max BWA_{SW}	2%	181.08-1034.25	536.53	0%-100%	100%	11.2	6.0	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}	2%	0.00-531.43	168.80	6%-60%	4%	8.3	1.0	0.00-0.00	0.00	0%
	C3		min BWA_{SW}	2%	0.00-6.78	1.13	0%-37%	0%	4.4	0.1	105.58-394.77	250.17	53%
	D1	60% DFL	max BWA_{SW}	9%	181.08-1034.25	536.53	0%-100%	100%	11.2	6.0	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}	9%	0.00-531.43	168.80	6%-60%	4%	8.3	1.0	0.00-0.00	0.00	0%
	D3		min BWA_{SW}	9%	0.00-6.78	1.13	0%-37%	0%	4.4	0.1	31.31-320.49	175.90	32%
Ilam	**A1**	100% DFL	max BWA_{SW}	2%	258.47-2114.95	987.99	8%-100%	100%	11.6	5.7	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}	2%	0.00-1159.94	339.18	4%-39%	2%	7.4	0.3	0.00-0.00	0.00	0%
	A3		min BWA_{SW}	2%	0.00-70.96	11.83	0%-20%	0%	2.2	0.0	0.00-0.00	0.00	0%
	B1	85% DFL	max BWA_{SW}	3%	258.47-2114.95	987.99	8%-100%	100%	11.6	5.7	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}	3%	0.00-1159.94	339.18	4%-39%	2%	7.4	0.3	0.00-0.00	0.00	0%
	B3		min BWA_{SW}	3%	0.00-70.96	11.83	0%-20%	0%	2.2	0.0	0.00-0.00	0.00	0%
	C1	75% DFL	max BWA_{SW}	4%	258.47-2114.95	987.99	8%-100%	100%	11.6	5.7	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}	4%	0.00-1159.94	339.18	4%-39%	2%	7.4	0.3	0.00-0.00	0.00	0%
	C3		min BWA_{SW}	4%	0.00-70.96	11.83	0%-20%	0%	2.2	0.0	0.00-0.00	0.00	0%
	D1	60% DFL	max BWA_{SW}	7%	258.47-2114.95	987.99	8%-100%	100%	11.6	5.7	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}	7%	0.00-1159.94	339.18	4%-39%	2%	7.4	0.3	0.00-0.00	0.00	0%
	D3		min BWA_{SW}	7%	0.00-70.96	11.83	0%-20%	0%	2.2	0.0	0.00-0.00	0.00	0%
Kerman	**A1**	100% DFL	max BWA_{SW}	0%	270.85-1771.03	943.89	0%-100%	100%	10.4	5.5	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}	0%	0.00-853.32	283.44	7%-29%	1%	7.4	0.7	0.00-254.07	63.52	2%
	A3		min BWA_{SW}	0%	0.00-0.00	0.00	0%-10%	0%	3.0	0.0	0.00-1207.52	586.27	22%
	B1	85% DFL	max BWA_{SW}	1%	270.85-1771.03	943.89	0%-100%	100%	10.4	5.5	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}	1%	0.00-853.32	283.44	7%-29%	1%	7.4	0.7	0.00-227.19	56.80	2%
	B3		min BWA_{SW}	1%	0.00-0.00	0.00	0%-10%	0%	3.0	0.0	0.00-1180.65	566.11	21%
	C1	75% DFL	max BWA_{SW}	2%	270.85-1771.03	943.89	0%-100%	100%	10.4	5.5	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}	2%	0.00-853.32	283.44	7%-29%	1%	7.4	0.7	0.00-182.04	45.51	1%
	C3		min BWA_{SW}	2%	0.00-0.00	0.00	0%-10%	0%	3.0	0.0	0.00-1135.49	532.25	20%
	D1	60% DFL	max BWA_{SW}	6%	270.85-1771.03	943.89	0%-100%	100%	10.4	5.5	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}	6%	0.00-853.32	283.44	7%-29%	1%	7.4	0.7	0.00-54.28	13.57	0%
	D3		min BWA_{SW}	6%	0.00-0.00	0.00	0%-10%	0%	3.0	0.0	0.00-1007.74	436.43	15%
Kermanshah	**A1**	100% DFL	max BWA_{SW}	0%	171.68-1333.37	657.73	0%-100%	100%	11.3	5.0	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}	0%	0.00-676.21	205.13	3%-11%	0%	6.6	0.2	0.00-0.00	0.00	0%
	A3		min BWA_{SW}	0%	0.00-0.00	0.00	0%-0%	0%	0.5	0.0	0.00-211.52	52.88	3%
	B1		max BWA_{SW}	1%	171.68-1333.37	657.73	0%-100%	100%	11.3	5.0	0.00-0.00	0.00	0%

	B2	85% DFL	ave BWA_{SW}	1%	0.00-676.21	205.13	3%-11%	0%	6.6	0.2	0.00-0.00	0.00	0%
	B3		min BWA_{SW}	1%	0.00-0.00	0.00	0%-0%	0%	0.5	0.0	0.00-199.90	49.97	3%
	C1	75% DFL	max BWA_{SW}	2%	171.68-1333.37	657.73	0%-100%	100%	11.3	5.0	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}	2%	0.00-676.21	205.13	3%-11%	0%	6.6	0.2	0.00-0.00	0.00	0%
	C3		min BWA_{SW}	2%	0.00-0.00	0.00	0%-0%	0%	0.5	0.0	0.00-190.60	47.65	3%
	D1	60% DFL	max BWA_{SW}	4%	171.68-1333.37	657.73	0%-100%	100%	11.3	5.0	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}	4%	0.00-676.21	205.13	3%-11%	0%	6.6	0.2	0.00-0.00	0.00	0%
	D3		min BWA_{SW}	4%	0.00-0.00	0.00	0%-0%	0%	0.5	0.0	0.00-161.55	40.39	2%
Khuzestan	**A1**	100% DFL	max BWA_{SW}	0%	295.40-2574.74	1275.02	0%-100%	92%	10.9	5.4	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}	0%	0.00-1335.76	438.12	6%-35%	1%	7.2	1.0	261.32-619.91	440.61	85%
	A3		min BWA_{SW}	0%	0.00-0.00	0.00	0%-15%	0%	2.1	0.0	1701.93-2060.52	1881.23	100%
	B1	85% DFL	max BWA_{SW}	1%	295.40-2574.74	1275.02	0%-100%	92%	10.9	5.4	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}	1%	0.00-1335.76	438.12	6%-35%	1%	7.2	1.0	219.74-578.32	399.03	76%
	B3		min BWA_{SW}	1%	0.00-0.00	0.00	0%-15%	0%	2.1	0.0	1660.35-2018.93	1839.64	100%
	C1	75% DFL	max BWA_{SW}	2%	295.40-2574.74	1275.02	0%-100%	92%	10.9	5.4	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}	2%	0.00-1335.76	438.12	6%-35%	1%	7.2	1.0	167.63-526.21	346.92	63%
	C3		min BWA_{SW}	2%	0.00-0.00	0.00	0%-15%	0%	2.1	0.0	1608.24-1966.82	1787.53	100%
	D1	60% DFL	max BWA_{SW}	8%	295.40-2574.74	1275.02	0%-100%	92%	10.9	5.4	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}	8%	0.00-1335.76	438.12	6%-35%	1%	7.2	1.0	0.00-294.38	131.14	17%
	D3		min BWA_{SW}	8%	0.00-0.00	0.00	0%-15%	0%	2.1	0.0	1376.41-1734.99	1555.70	100%
Kohgiluieh	**A1**	100% DFL	max BWA_{SW}	1%	552.86-4166.65	1925.66	0%-100%	100%	11.8	6.0	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}	1%	0.00-2351.13	669.02	4%-67%	3%	8.2	0.5	0.00-0.00	0.00	0%
	A3		min BWA_{SW}	1%	0.00-288.65	48.11	0%-44%	0%	3.5	0.0	0.00-0.00	0.00	0%
	B1	85% DFL	max BWA_{SW}	2%	552.86-4166.65	1925.66	0%-100%	100%	11.8	6.0	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}	2%	0.00-2351.13	669.02	4%-67%	3%	8.2	0.5	0.00-0.00	0.00	0%
	B3		min BWA_{SW}	2%	0.00-288.65	48.11	0%-44%	0%	3.5	0.0	0.00-0.00	0.00	0%
	C1	75% DFL	max BWA_{SW}	3%	552.86-4166.65	1925.66	0%-100%	100%	11.8	6.0	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}	3%	0.00-2351.13	669.02	4%-67%	3%	8.2	0.5	0.00-0.00	0.00	0%
	C3		min BWA_{SW}	3%	0.00-288.65	48.11	0%-44%	0%	3.5	0.0	0.00-0.00	0.00	0%
	D1	60% DFL	max BWA_{SW}	4%	552.86-4166.65	1925.66	0%-100%	100%	11.8	6.0	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}	4%	0.00-2351.13	669.02	4%-67%	3%	8.2	0.5	0.00-0.00	0.00	0%
	D3		min BWA_{SW}	4%	0.00-288.65	48.11	0%-44%	0%	3.5	0.0	0.00-0.00	0.00	0%
Kordestan	**A1**	100% DFL	max BWA_{SW}	0%	396.22-3209.03	1590.24	0%-100%	100%	11.3	4.9	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}	0%	0.00-1622.38	486.88	4%-11%	0%	6.6	0.2	0.00-0.00	0.00	0%
	A3		min BWA_{SW}	0%	0.00-0.00	0.00	0%-0%	0%	0.7	0.0	0.00-0.00	0.00	0%
	B1	85% DFL	max BWA_{SW}	1%	396.22-3209.03	1590.24	0%-100%	100%	11.3	4.9	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}	1%	0.00-1622.38	486.88	4%-11%	0%	6.6	0.2	0.00-0.00	0.00	0%
	B3		min BWA_{SW}	1%	0.00-0.00	0.00	0%-0%	0%	0.7	0.0	0.00-0.00	0.00	0%
	C1	75% DFL	max BWA_{SW}	3%	396.22-3209.03	1590.24	0%-100%	100%	11.3	4.9	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}	3%	0.00-1622.38	486.88	4%-11%	0%	6.6	0.2	0.00-0.00	0.00	0%
	C3		min BWA_{SW}	3%	0.00-0.00	0.00	0%-0%	0%	0.7	0.0	0.00-0.00	0.00	0%
	D1	60% DFL	max BWA_{SW}	7%	396.22-3209.03	1590.24	0%-100%	100%	11.3	4.9	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}	7%	0.00-1622.38	486.88	4%-11%	0%	6.6	0.2	0.00-0.00	0.00	0%
	D3		min BWA_{SW}	7%	0.00-0.00	0.00	0%-0%	0%	0.7	0.0	0.00-0.00	0.00	0%
Lorestan	**A1**	100% DFL	max BWA_{SW}	0%	387.62-2819.40	1422.11	40%-100%	100%	11.5	5.3	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}	0%	0.00-1402.32	429.26	3%-10%	0%	6.6	0.2	0.00-0.00	0.00	0%
	A3		min BWA_{SW}	0%	0.00-0.00	0.00	0%-0%	0%	0.9	0.0	0.00-139.48	34.87	2%
	B1	85% DFL	max BWA_{SW}	1%	387.62-2819.40	1422.11	40%-100%	100%	11.5	5.3	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}	1%	0.00-1402.32	429.26	3%-10%	0%	6.6	0.2	0.00-0.00	0.00	0%

	B3		min BWA_{SW}	1%	0.00-0.00	0.00	0%-0%	0%	0.9	0.0	0.00-112.12	28.03	1%
	C1	75% DFL	max BWA_{SW}	2%	387.62-2819.40	1422.11	40%-100%	100%	11.5	5.3	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}	2%	0.00-1402.32	429.26	3%-10%	0%	6.6	0.2	0.00-0.00	0.00	0%
	C3		min BWA_{SW}	2%	0.00-0.00	0.00	0%-0%	0%	0.9	0.0	0.00-92.74	23.18	1%
	D1	60% DFL	max BWA_{SW}	3%	387.62-2819.40	1422.11	40%-100%	100%	11.5	5.3	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}	3%	0.00-1402.32	429.26	3%-10%	0%	6.6	0.2	0.00-0.00	0.00	0%
	D3		min BWA_{SW}	3%	0.00-0.00	0.00	0%-0%	0%	0.9	0.0	0.00-62.68	15.67	1%
Markazi	**A1**	100% DFL	max BWA_{SW}	0%	57.13-442.72	218.30	0%-100%	100%	11.6	6.1	0.00-274.79	77.76	4%
	A2		ave BWA_{SW}	0%	0.00-224.73	68.93	4%-10%	0%	6.6	0.2	0.00-492.78	190.69	12%
	A3		min BWA_{SW}	0%	0.00-0.00	0.00	0%-0%	0%	0.7	0.0	8.56-724.16	366.36	26%
	B1	85% DFL	max BWA_{SW}	2%	57.13-442.72	218.30	0%-100%	100%	11.6	6.1	0.00-249.05	64.89	3%
	B2		ave BWA_{SW}	2%	0.00-224.73	68.93	4%-10%	0%	6.6	0.2	0.00-467.04	173.89	10%
	B3		min BWA_{SW}	2%	0.00-0.00	0.00	0%-0%	0%	0.7	0.0	0.00-698.42	344.91	24%
	C1	75% DFL	max BWA_{SW}	4%	57.13-442.72	218.30	0%-100%	100%	11.6	6.1	0.00-215.55	53.89	3%
	C2		ave BWA_{SW}	4%	0.00-224.73	68.93	4%-10%	0%	6.6	0.2	0.00-433.53	157.13	9%
	C3		min BWA_{SW}	4%	0.00-0.00	0.00	0%-0%	0%	0.7	0.0	0.00-664.91	319.79	22%
	D1	60% DFL	max BWA_{SW}	12%	57.13-442.72	218.30	0%-100%	100%	11.6	6.1	0.00-120.44	30.11	1%
	D2		ave BWA_{SW}	12%	0.00-224.73	68.93	4%-10%	0%	6.6	0.2	0.00-338.42	109.58	6%
	D3		min BWA_{SW}	12%	0.00-0.00	0.00	0%-0%	0%	0.7	0.0	0.00-569.80	248.45	16%
Mazandaran	**A1**	100% DFL	max BWA_{SW}	0%	215.16-2876.37	1232.49	48%-100%	87%	11.9	4.7	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}	0%	0.00-1652.87	469.93	2%-7%	0%	6.1	0.0	0.00-0.00	0.00	0%
	A3		min BWA_{SW}	0%	0.00-32.48	5.41	0%-0%	0%	0.4	0.0	0.00-229.16	77.61	7%
	B1	85% DFL	max BWA_{SW}	3%	215.16-2876.37	1232.49	48%-100%	87%	11.9	4.7	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}	3%	0.00-1652.87	469.93	2%-7%	0%	6.1	0.0	0.00-0.00	0.00	0%
	B3		min BWA_{SW}	3%	0.00-32.48	5.41	0%-0%	0%	0.4	0.0	0.00-199.50	62.78	6%
	C1	75% DFL	max BWA_{SW}	7%	215.16-2876.37	1232.49	48%-100%	87%	11.9	4.7	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}	7%	0.00-1652.87	469.93	2%-7%	0%	6.1	0.0	0.00-0.00	0.00	0%
	C3		min BWA_{SW}	7%	0.00-32.48	5.41	0%-0%	0%	0.4	0.0	0.00-152.32	39.19	3%
	D1	60% DFL	max BWA_{SW}	16%	215.16-2876.37	1232.49	48%-100%	87%	11.9	4.7	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}	16%	0.00-1652.87	469.93	2%-7%	0%	6.1	0.0	0.00-0.00	0.00	0%
	D3		min BWA_{SW}	16%	0.00-32.48	5.41	0%-0%	0%	0.4	0.0	0.00-54.89	13.72	1%
NorthKhorasan	**A1**	100% DFL	max BWA_{SW}	0%	45.02-399.59	195.60	0%-100%	88%	10.7	5.5	504.45-712.09	608.27	100%
	A2		ave BWA_{SW}	0%	0.00-203.99	61.27	7%-26%	0%	6.6	1.1	700.05-907.69	803.87	100%
	A3		min BWA_{SW}	0%	0.00-0.00	0.00	0%-0%	0%	1.5	0.0	908.49-1116.13	1012.31	100%
	B1	85% DFL	max BWA_{SW}	4%	45.02-399.59	195.60	0%-100%	88%	10.7	5.5	438.95-646.58	542.76	100%
	B2		ave BWA_{SW}	4%	0.00-203.99	61.27	7%-26%	0%	6.6	1.1	634.55-842.18	738.36	100%
	B3		min BWA_{SW}	4%	0.00-0.00	0.00	0%-0%	0%	1.5	0.0	842.98-1050.62	946.80	100%
	C1	75% DFL	max BWA_{SW}	9%	45.02-399.59	195.60	0%-100%	88%	10.7	5.5	360.71-568.35	464.53	100%
	C2		ave BWA_{SW}	9%	0.00-203.99	61.27	7%-26%	0%	6.6	1.1	556.31-763.95	660.13	100%
	C3		min BWA_{SW}	9%	0.00-0.00	0.00	0%-0%	0%	1.5	0.0	764.75-972.38	868.56	100%
	D1	60% DFL	max BWA_{SW}	20%	45.02-399.59	195.60	0%-100%	88%	10.7	5.5	194.91-402.55	298.73	97%
	D2		ave BWA_{SW}	20%	0.00-203.99	61.27	7%-26%	0%	6.6	1.1	390.51-598.15	494.33	100%
	D3		min BWA_{SW}	20%	0.00-0.00	0.00	0%-0%	0%	1.5	0.0	598.94-806.58	702.76	100%
RazaviKhorasan	**A1**	100% DFL	max BWA_{SW}	0%	112.09-867.86	435.35	0%-100%	92%	10.7	5.5	0.00-625.55	217.47	8%
	A2		ave BWA_{SW}	0%	0.00-432.51	129.65	6%-26%	1.67E-16	6.6	0.9	0.00-1060.90	509.75	22%
	A3		min BWA_{SW}	0%	0.00-0.00	0.00	0%-0%	0%	1.4	0.0	374.36-1518.07	946.21	49%
	B1	85% DFL	max BWA_{SW}	1%	112.09-867.86	435.35	0%-100%	92%	10.7	5.5	0.00-586.18	197.78	7%
	B2		ave BWA_{SW}	1%	0.00-432.51	129.65	6%-26%	1.67E-16	6.6	0.9	0.00-1021.52	480.21	20%
	B3		min BWA_{SW}	1%	0.00-0.00	0.00	0%-0%	0%	1.4	0.0	334.98-1478.69	906.84	46%

	C1	75% DFL	max BWA_{SW}	3%	112.09-867.86	435.35	0%-100%	92%	10.7	5.5	0.00-519.78	164.58	6%
	C2		ave BWA_{SW}	3%	0.00-432.51	129.65	6%-26%	1.67E-16	6.6	0.9	0.00-955.12	430.41	17%
	C3		min BWA_{SW}	3%	0.00-0.00	0.00	0%-0%	0%	1.4	0.0	268.58-1412.29	840.44	42%
	D1	60% DFL	max BWA_{SW}	8%	112.09-867.86	435.35	0%-100%	92%	10.7	5.5	0.00-342.75	85.69	3%
	D2		ave BWA_{SW}	8%	0.00-432.51	129.65	6%-26%	1.67E-16	6.6	0.9	0.00-778.09	297.64	11%
	D3		min BWA_{SW}	8%	0.00-0.00	0.00	0%-0%	0%	1.4	0.0	91.55-1235.26	663.41	30%
Semnan	**A1**	100% DFL	max BWA_{SW}	0%	21.74-197.00	97.93	44%-100%	95%	10.8	5.8	0.00-120.23	46.63	12%
	A2		ave BWA_{SW}	0%	0.00-99.07	29.77	7%-27%	0%	6.6	1.1	43.99-218.16	131.08	43%
	A3		min BWA_{SW}	0%	0.00-0.00	0.00	0%-0%	0%	1.4	0.0	147.13-321.30	234.22	93%
	B1	85% DFL	max BWA_{SW}	1%	21.74-197.00	97.93	44%-100%	95%	10.8	5.8	0.00-112.20	41.59	10%
	B2		ave BWA_{SW}	1%	0.00-99.07	29.77	7%-27%	0%	6.6	1.1	35.96-210.13	123.05	39%
	B3		min BWA_{SW}	1%	0.00-0.00	0.00	0%-0%	0%	1.4	0.0	139.10-313.27	226.19	90%
	C1	75% DFL	max BWA_{SW}	3%	21.74-197.00	97.93	44%-100%	95%	10.8	5.8	0.00-98.38	34.67	8%
	C2		ave BWA_{SW}	3%	0.00-99.07	29.77	7%-27%	0%	6.6	1.1	22.14-196.31	109.22	33%
	C3		min BWA_{SW}	3%	0.00-0.00	0.00	0%-0%	0%	1.4	0.0	125.27-299.45	212.36	85%
	D1	60% DFL	max BWA_{SW}	8%	21.74-197.00	97.93	44%-100%	95%	10.8	5.8	0.00-66.34	18.65	4%
	D2		ave BWA_{SW}	8%	0.00-99.07	29.77	7%-27%	0%	6.6	1.1	0.00-164.27	79.66	22%
	D3		min BWA_{SW}	8%	0.00-0.00	0.00	0%-0%	0%	1.4	0.0	93.24-267.41	180.32	69%
Sistan	**A1**	100% DFL	max BWA_{SW}	0%	218.71-1342.93	714.59	0%-100%	100%	10.4	5.7	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}	0%	0.00-652.05	215.35	7%-33%	2%	7.5	0.8	0.00-0.00	0.00	0%
	A3		min BWA_{SW}	0%	0.00-0.00	0.00	0%-13%	0%	3.1	0.0	334.89-679.94	507.42	99%
	B1	85% DFL	max BWA_{SW}	1%	218.71-1342.93	714.59	0%-100%	100%	10.4	5.7	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}	1%	0.00-652.05	215.35	7%-33%	2%	7.5	0.8	0.00-0.00	0.00	0%
	B3		min BWA_{SW}	1%	0.00-0.00	0.00	0%-13%	0%	3.1	0.0	321.79-666.84	494.32	97%
	C1	75% DFL	max BWA_{SW}	2%	218.71-1342.93	714.59	0%-100%	100%	10.4	5.7	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}	2%	0.00-652.05	215.35	7%-33%	2%	7.5	0.8	0.00-0.00	0.00	0%
	C3		min BWA_{SW}	2%	0.00-0.00	0.00	0%-13%	0%	3.1	0.0	289.52-634.57	462.04	93%
	D1	60% DFL	max BWA_{SW}	7%	218.71-1342.93	714.59	0%-100%	100%	10.4	5.7	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}	7%	0.00-652.05	215.35	7%-33%	2%	7.5	0.8	0.00-0.00	0.00	0%
	D3		min BWA_{SW}	7%	0.00-0.00	0.00	0%-13%	0%	3.1	0.0	210.35-555.40	382.88	76%
SouthKhorasan	**A1**	100% DFL	max BWA_{SW}	0%	35.87-270.42	141.60	66%-100%	97%	11.0	5.1	874.67-1083.42	979.04	100%
	A2		ave BWA_{SW}	0%	0.00-129.96	39.82	7%-25%	0%	6.8	0.8	1015.13-1223.88	1119.50	100%
	A3		min BWA_{SW}	0%	0.00-0.00	0.00	0%-0%	0%	1.7	0.0	1158.25-1367.00	1262.63	100%
	B1	85% DFL	max BWA_{SW}	1%	35.87-270.42	141.60	66%-100%	97%	11.0	5.1	861.53-1070.27	965.90	100%
	B2		ave BWA_{SW}	1%	0.00-129.96	39.82	7%-25%	0%	6.8	0.8	1001.98-1210.73	1106.36	100%
	B3		min BWA_{SW}	1%	0.00-0.00	0.00	0%-0%	0%	1.7	0.0	1145.11-1353.85	1249.48	100%
	C1	75% DFL	max BWA_{SW}	2%	35.87-270.42	141.60	66%-100%	97%	11.0	5.1	825.48-1034.23	929.86	100%
	C2		ave BWA_{SW}	2%	0.00-129.96	39.82	7%-25%	0%	6.8	0.8	965.94-1174.69	1070.31	100%
	C3		min BWA_{SW}	2%	0.00-0.00	0.00	0%-0%	0%	1.7	0.0	1109.06-1317.81	1213.44	100%
	D1	60% DFL	max BWA_{SW}	12%	35.87-270.42	141.60	66%-100%	97%	11.0	5.1	657.07-865.82	761.45	100%
	D2		ave BWA_{SW}	12%	0.00-129.96	39.82	7%-25%	0%	6.8	0.8	797.53-1006.28	901.90	100%
	D3		min BWA_{SW}	12%	0.00-0.00	0.00	0%-0%	0%	1.7	0.0	940.65-1149.40	1045.03	100%
Tehran	**A1**	100% DFL	max BWA_{SW}	0%	100.20-653.44	340.38	0%-100%	100%	10.8	5.5	632.21-1056.51	844.36	100%
	A2		ave BWA_{SW}	0%	0.00-313.71	95.12	6%-27%	0%	6.6	0.8	971.94-1396.23	1184.08	100%
	A3		min BWA_{SW}	0%	0.00-0.00	0.00	0%-0%	0%	1.4	0.0	1311.87-1736.17	1524.02	100%
	B1	85% DFL	max BWA_{SW}	2%	100.20-653.44	340.38	0%-100%	100%	10.8	5.5	566.53-990.83	778.68	100%
	B2		ave BWA_{SW}	2%	0.00-313.71	95.12	6%-27%	0%	6.6	0.8	906.25-1330.55	1118.40	100%
	B3		min BWA_{SW}	2%	0.00-0.00	0.00	0%-0%	0%	1.4	0.0	1246.19-1670.49	1458.34	100%
	C1		max BWA_{SW}	6%	100.20-653.44	340.38	0%-100%	100%	10.8	5.5	485.62-909.92	697.77	100%

	C2	75% DFL	ave BWA_{SW}	6%	0.00-313.71	95.12	6%-27%	0%	6.6	0.8	825.34-1249.64	1037.49	100%
	C3		min BWA_{SW}	6%	0.00-0.00	0.00	0%-0%	0%	1.4	0.0	1165.28-1589.58	1377.43	100%
	D1	60% DFL	max BWA_{SW}	16%	100.20-653.44	340.38	0%-100%	100%	10.8	5.5	242.50-666.79	454.65	73%
	D2		ave BWA_{SW}	16%	0.00-313.71	95.12	6%-27%	0%	6.6	0.8	582.22-1006.52	794.37	100%
	D3		min BWA_{SW}	16%	0.00-0.00	0.00	0%-0%	0%	1.4	0.0	922.16-1346.45	1134.31	100%
Yazd	**A1**	100% DFL	max BWA_{SW}	0%	66.01-505.44	260.38	0%-100%	94%	10.4	6.0	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}	0%	0.00-246.65	75.96	8%-26%	0%	7.0	0.9	0.00-99.09	25.65	3%
	A3		min BWA_{SW}	0%	0.00-0.00	0.00	0%-0%	0%	2.1	0.0	84.30-371.07	227.68	47%
	B1	85% DFL	max BWA_{SW}	2%	66.01-505.44	260.38	0%-100%	94%	10.4	6.0	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}	2%	0.00-246.65	75.96	8%-26%	0%	7.0	0.9	0.00-80.24	20.06	3%
	B3		min BWA_{SW}	2%	0.00-0.00	0.00	0%-0%	0%	2.1	0.0	65.46-352.22	208.84	41%
	C1	75% DFL	max BWA_{SW}	4%	66.01-505.44	260.38	0%-100%	94%	10.4	6.0	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}	4%	0.00-246.65	75.96	8%-26%	0%	7.0	0.9	0.00-57.12	14.28	2%
	C3		min BWA_{SW}	4%	0.00-0.00	0.00	0%-0%	0%	2.1	0.0	42.33-329.10	185.71	35%
	D1	60% DFL	max BWA_{SW}	9%	66.01-505.44	260.38	0%-100%	94%	10.4	6.0	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}	9%	0.00-246.65	75.96	8%-26%	0%	7.0	0.9	0.00-11.44	2.86	0%
	D3		min BWA_{SW}	9%	0.00-0.00	0.00	0%-0%	0%	2.1	0.0	0.00-283.42	140.87	24%
Zanjan	**A1**	100% DFL	max BWA_{SW}	0%	142.70-1010.86	505.99	0%-100%	100%	11.4	5.3	0.00-0.00	0.00	0%
	A2		ave BWA_{SW}	0%	0.00-505.29	153.28	3%-11%	0%	6.6	0.2	0.00-0.00	0.00	0%
	A3		min BWA_{SW}	0%	0.00-0.00	0.00	0%-0%	0%	0.5	0.0	256.85-490.90	373.87	100%
	B1	85% DFL	max BWA_{SW}	2%	142.70-1010.86	505.99	0%-100%	100%	11.4	5.3	0.00-0.00	0.00	0%
	B2		ave BWA_{SW}	2%	0.00-505.29	153.28	3%-11%	0%	6.6	0.2	0.00-0.00	0.00	0%
	B3		min BWA_{SW}	2%	0.00-0.00	0.00	0%-0%	0%	0.5	0.0	232.98-467.03	350.01	100%
	C1	75% DFL	max BWA_{SW}	5%	142.70-1010.86	505.99	0%-100%	100%	11.4	5.3	0.00-0.00	0.00	0%
	C2		ave BWA_{SW}	5%	0.00-505.29	153.28	3%-11%	0%	6.6	0.2	0.00-0.00	0.00	0%
	C3		min BWA_{SW}	5%	0.00-0.00	0.00	0%-0%	0%	0.5	0.0	204.74-438.79	321.77	94%
	D1	60% DFL	max BWA_{SW}	11%	142.70-1010.86	505.99	0%-100%	100%	11.4	5.3	0.00-0.00	0.00	0%
	D2		ave BWA_{SW}	11%	0.00-505.29	153.28	3%-11%	0%	6.6	0.2	0.00-0.00	0.00	0%
	D3		min BWA_{SW}	11%	0.00-0.00	0.00	0%-0%	0%	0.5	0.0	137.81-371.86	254.83	74%